ARMY RESEARCH AND DEVELOPMENT

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ARO Reorganization Changes OOR Control

Theme of the Month

By Lieutenant General A. G. Trudeau
Chief of Research and Development

An optimum division of our efforts and resources between basic research, applied research, and development will result only from careful and continuing thought on the subject. Superficial studies will place undue emphasis on the latter two. Following are two reasons for this.

First, the contributions of basic research are subtle—less patent than those of either applied research or development. Subconsciously, popular thought ascribes the impressive weapons systems of today to the ingenious and imaginative engineers who last had a hand in bringing them into being; and they do deserve great credit. But the foundation of their achievements is imbedded in the results of the less spectacular pursuits of creative men of pure science who,

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Direct administrative, funding and policy control exercised by the Chief of Research and Development over all Department of the Army basic research activities is strengthened by the recent reorganization of the Army Research Office, including transfer to ARO of the Office of Ordnance Research.

Aimed at improved management of the Army's expanding, diffused and widely dispersed basic research program, the revised framework of ARO is in line with recommendations of the Roderick Board, as approved in August 1960 by Secretary of the Army Wilber M. Brucker.

Effective Jan. 16, the Office of Ordnance Research was redesignated Army Research Office-Durham and will re-

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Newsmagazine Offered On Subscription Basis

Effective with the current issue, the *Army Research and Development Newsmagazine* is available through the Superintendent of Documents, United States Government Printing Office, Washington 25, D.C. Subscription rates are: $2.25 annually (12 issues) in the U.S.; $3.00, foreign countries; $0.20 a single copy. No back copies are available.

Arrangements for sale of the *Newsmagazine* through the Superintendent of Documents were made in response to numerous requests from industrial firms, other institutions and individuals who are not eligible for official distribution. Distribution of the *Newsmagazine* is restricted to Army research and development activities, Army staff agencies, and other Government agencies having an interest in the Army R&D program.

Signal Corps Cited for Safety

The Department of the Army's 1960 Award of Honor for Safety, the highest given by the Army, was awarded to the Army Signal Corps, which had also won the award in 1958. Maj. Gen. S. L. Myers, Assistant Deputy Chief of Staff for Logistics, presented the award plaque to Maj. Gen. Earle F. Cook, Deputy Chief Signal Officer.

NIKE ZEUS, the Army anti-missile missile, is undergoing preliminary testing at White Sands Missile Range while facilities in the Pacific are being readied for intercept tests against an actual ICBM target. (See White Sands, Cradled Missile Era, page 4.)

Army R&D Newsmagazine

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Objectives of this publication are: To improve informal communication among all segments of the Army scientific community and other Government R&D agencies; to further understanding of Army R&D progress, problem areas and program planning; to stimulate more closely integrated and coordinated effort among the widely dispersed and diffused Army R&D activities; to maintain a closer link from top management through all levels to scientists, engineers and technicians at the bench level; to express views of leaders, as pertinent to their responsibilities, and to keep personnel informed on matters germane to their welfare and pride of service.

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Submission of Material: All articles submitted for publication must be channeled through the technical liaison or public information officer at installation or command level.

Army Trucks Evaluated

Evaluation of the adaptability of various types of Army trucks to extremes of temperature was the purpose of an experimental 3,500-mile motorcade from Arizona to Alaska. A spokesman at Aberdeen Proving Grounds, Md., said some of the trucks have new engines that can burn high octane gasoline, kerosene, or jet fuel.

THEME OF THE MONTH

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probing the outer fringes of man's knowledge, constantly add to that knowledge.

The United States, at the close of World War II, had a truly magnificent fighting force equipped with the latest weapons of the day. While the majority of us were so occupied with admiring our wealth that we could not see our poverty, *Dr. Vannevar Bush, thinking more deeply, pointed out, "We've used up 50 years of basic research in 5 years of war. . . ."*

Secondly, the contributions of basic research make their impact in the future. Problems appear important to man not only in relation to their size but also in relation to their proximity. It is only natural, then, that winning the battle of Armageddon, if it occurs tomorrow, looms large in our minds. The Western World must win that battle. Simultaneously we must come to grips with two other equally important objectives: deterring Armageddon into the indefinite future, or winning it if it occurs 10 or 20 years in the future. These latter objectives will not be attained through the weapons of today, but only through weapons founded on new knowledge extracted from what we know are the endless frontiers of science—knowledge which will not yield itself directly to the developer of the end product.

The vital role of applied research, of course, must not be overlooked. The Army relies upon this endeavor for direct aid in improving or making great advances in specific end items or systems. But the Army also needs applied research in order to discover the implications and the richness of new scientific knowledge and to lay bare new possibilities in the military application of science. Creative and imaginative effort here will assist significantly in making great strides forward in all of the methods, techniques, and equipment of our Army. To this end, there should be more applied, supporting, and component research, independent of systems development.

This is not to stipulate a specific level of spending for each of our efforts, but to suggest the complexity and the importance of the problem of arriving at the happiest division of our resources. With the best balance struck, and with maximum communication between the various talents of our outstanding Army R&D work force, we will make maximum use of that all important commodity—time.

The men of pure science will continue to turn over more and more data on the mysterious and immutable laws of nature to the applied researcher and the engineer, who carry through the process of commanding nature to serve our military ends by obeying her. The visionary applied researcher will discover rapidly the diverse profitable applications of new knowledge to the many technical requirements of the Army. The engineer will always have new scientific material to turn into military potential at the maximum possible rate.

All three of these vital members of the Army R&D team will furnish stimuli, suggestions, and means for further effective action, to each other in their separate fields. The accomplishments of this harmonic effort are maximized by an optimum balance between the three pursuits—basic research, applied research, and development.

ARO Reorganization Changes OOR Control

(*Continued from page 1*)

ceive personnel and funding increases commensurate with a projected substantial growth of its functions. The present staff consists of 109 employees with technical interests in the fields of mathematics, chemistry, physics, engineering sciences and metallurgy.

Precise details of the functions and operating procedures of ARO-Durham, as well as other major components of ARO, remained to be determined as the *Army Research and Development Newsmagazine* went to press. Dr. Richard A. Weiss, Deputy and Scientific Director of Army Research, was named chairman of an Ad Hoc Committee appointed to make recommendations following a series of exploratory discussions.

Broad agreements governing the reorganization of ARO, and the part that ARO-Durham will play operationally in the physical sciences research activities through the Army's seven Technical Services, were reached Dec. 20 at a meeting in the office of Mr. Richard S. Morse, director of Research and Development.

Reorganization of ARO involved redesignation of several elements and constitution of three divisions in addition to a number of new branches, most notably a Technological Forecasting Branch in response to a long-recognized need.

Overseas offices are to be renamed ARO-Frankfurt and ARO-Tokyo. Earth Sciences Division supplanted the

OOR Located on Campus of Duke University

Headquarters of the Office of Ordnance Research is this building on Duke University campus, built in 1958, which is leased to the Department of the Army.

Environmental Sciences Division, and the Research Planning Division is composed of substantially the same personnel as served in the discontinued Operations Research Division. New also is a Research Programs Division. The Life Sciences Division, Human Factors Research Division, Physical Sciences Division, and Research Support Division remain unchanged except for internal realignments.

General Trudeau's Statement

Lt Gen Arthur G. Trudeau, Chief of Research and Development, expressed his views on reorganization of the Army Research Office by saying:

"Our basic research may be divided into two categories, essentially. Internal research is that conducted in Army laboratories; external research is that supported by the Army through contracts or grants to universities, nonprofit organizations and industry.

"I propose to conduct the internal basic research programs within the Army laboratories essentially as conducted at present. However, in the area of external research I propose to bring the Army Research Office into much closer contact and control of this program.

"To this end, as a first step, the Chief of Staff has approved the transfer of the Office of Ordnance Research to my control. I propose to expand this organization to carry out, for the Army, the functions in the physical sciences which it presently carries out for the Chief of Ordnance. ARO-Durham will monitor basic research in the physical sciences; basic research in the life sciences, the psychological and sociological sciences, and the earth sciences will be handled through headquarters the Army Research Office in Arlington, Va.

"These organizational changes will permit the Army to program, on an annual basis, an assured and constant funding for basic research. I believe that a research program which approximates at least 5 percent of the total research, development, testing and evaluation budget is a good rough figure to shoot at."

Commenting on the role projected for ARO-Durham, Dr. R. A. Weiss, Deputy and Scientific Director of Army Research, said:

"The manner in which the Office of Ordnance Research has managed and nurtured basic research during the past nine years has earned the respect of both the military and the outside scientific community to the extent that the work supported by OOR has become synonymous with the Army's program in basic research. Since OOR has done such a remarkably fine job, the Chief of Research and Development has directed that OOR be delegated with overall responsibility for operations in the physical sciences basic research activities."

Located on the campus of Duke University at Durham, N.C., OOR was established in 1951 by the Chief of Ordnance and has been responsible for control, planning, direction and appraisal of basic research projects supported by the Ordnance Corps, in Ordnance laboratories as well as grants and contracts negotiated with universities, colleges and institutes.

As a supplementary official activity, OOR initiated a series of Junior Science and Humanities Symposia for selected high school students. Aimed originally for students in North Carolina alone, the symposia have enjoyed outstanding success and are now assuming national proportions.

Dr. Eklund Named Speaker For Joint Council Meeting

Dr. Carl R. Eklund, Head of the Polar Branch, Research Environmental Science Division, Army Research Office, will be guest speaker at a banquet of the Joint Council of Engineering and Scientific Societies of the Central Savannah River Area, to be held Feb. 23 at Augusta, Ga. In connection with the Council's celebration of National Engineers Week, Dr. Eklund will discuss various aspects of popular exploration.

The Joint Council is composed of local chapters of the American Society of Civil Engineers, American Society of Mechanical Engineers, American Institute of Electrical Engineers, American Institute of Chemical Engineers, American Chemical Society, American Society of Metals, Instrument Society of America, Georgia Society of Professional Engineers, South Carolina Society of Engineers, and Health Physics Society.

Building Satellite Payloads

Construction of three experimental satellite payloads, which will be launched starting early in 1962 on test vehicles of the National Aeronautics and Space Administration's Centaur series, is underway. The Convair Aeronautics Division of General Dynamics Corporation has the task under a $1.9 million contract awarded by the Advanced Research Projects Agency (ARPA). Intended to supply supporting data for future military space programs, the payloads will be placed in 22,000-mile orbits.

2 Contracts Call for Work On Hawk, Sergeant Missiles

Further research and development work on the Army's Hawk and Sergeant missile systems is called for by two recently awarded contracts.

A $2,250,000 contract with the Raytheon Co. for work on the Hawk was disclosed by the Boston Ordnance District. Hawk is a surface-to-air missile designed for defense against enemy air attacks at very low altitudes. It is equipped with a homing device guidance system and carries a conventional warhead.

The Los Angeles Ordnance District has awarded a $1,352,000 contract to the Sperry Utah Engineering Laboratory Division of the Sperry Rand Corp. for research and development work on the Sergeant, a solid fuel, surface-to-surface missile capable of delivering a nuclear or conventional warhead against enemy targets.

The Army Ballistic Agency, an element of the Army Ordnance Missile Command at Redstone Arsenal, Ala., is supervising both programs.

White Sands Range Has Cradled Missile Era

White Sands Missile Range, a 4,000-square-mile test center located in New Mexico near the site where Dr. Robert Goddard, American rocket pioneer, conducted his early experiments, will be 16 years old next July. It is the scene of "firsts" which shaped much of modern missile technology.

Research and development activities, carried on by the Army, Navy, and Air Force, employ 15,000; 8,500 are military personnel or Civil Service employees of the Army Ordnance Corps. The range measures approximately 100 miles in length and 40 miles in width. Because of the sand and granite topography, instrumentation is emplaced on a firm terrain table suitable for the precision measurements basic to successful scientific research in the field.

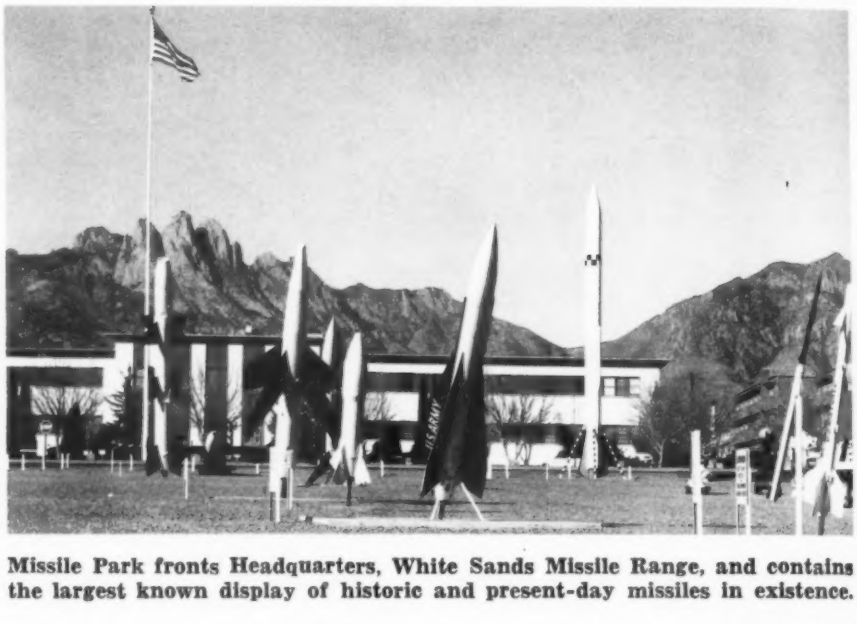
It was mid-July, 1945, when a small group of nuclear scientists saw the first atomic bomb detonate in the area that became White Sands Missile Range. Four months later a Tiny Tim rocket booster was successfully fired, marking the beginning of the development program that has steadily increased in scope and importance.

Recorded Many "Firsts"

The launching of captured and modified German V–2 rockets, the first extreme-altitude photographs of the earth from this same V–2, the world's altitude record of 250 miles set by the two-stage Bumper V–2, upper atmosphere discoveries by the Navy Aerobee, the first photographs of a missile in flight through the fringes of space, the first intercept of an aerial target by a guided missile (Nike Ajax)—these are just some of the programs accomplished in the early days of White Sands Missile Range that today leave a mark in all phases of the missile art.

More recently, of course, America's first missile range produced the first intercept of one missile by another—the ballistic rocket Honest John by the guided Hawk—and the destruction of the Army's surface-to-surface missile, the Corporal, by the ground-to-air Nike Hercules.

From 1945 until the '50s, the missile range stood alone as the big research and development center for most of this Nation's military missiles and rockets, and for atmospheric research vehicles as well. With the establishment of the Atlantic Missile Range, the missile tree began to branch and White Sands activity narrowed to the testing of tactical missiles. Still the largest all-land missile range in the hemisphere, White Sands lies between the Atlantic and the Pacific missile ranges, its size insignificant in comparison to the reaches of either oceanic range.



Missile Park fronts Headquarters, White Sands Missile Range, and contains the largest known display of historic and present-day missiles in existence.

Small though its physical dimensions are comparatively, WSMR's mission looms large. Here is situated nearly $100 million in facilities and components of the all-important Nike Zeus anti-missile missile system—R&D launchers, storage and assembly facilities, prototype acquisition and tracking radars, battery control equipment. Here has been carried out the early test phase of the Nike Zeus missile itself; the second phase of preliminary testing is underway, and research into the system's performance against actual high-ability aerial targets will soon be moving in high gear.

Behind the vital activity of the present is a story of intra-military harmony and military-civilian teamwork.

Established by the Secretary of Defense in 1952 as an integrated missile testing range for use by the three military services, White Sands on any given day might log test firings of an Army Sergeant, a Navy Talos and an Air Force Falcon. Allotment of range space and time, plus the assignment of some or all the varied precision instrumentation devices for each separate firing—nearly 2,500 "hot" missile firings have been conducted in a single year at WSMR—is a momentous task. The job is carried out for the Range Commander by the Integrated Range Mission, a military-civilian tri-service agency headed by an Ordnance Corps officer.

Supporting the range with instrumentation and communication is the Army Signal Missile Support Agency, WSMR's arm of the Signal Corps. Missile research and development activity is conducted for the Army Ordnance Missile Command by the Ordnance Mission; this WSMR agency is headed by a military officer responsible to the Commanding General.

Navy testing activity is under the Naval Ordnance Missile Test Facility; Air Force, under the Air Force Missile Development Center. The latter is physically located along the mid-eastern border of the range at Holloman Air Force Base, the former at the south end of the range with Ordnance and WSMR administrative facilities. An element of the Marine Corps is assigned to White Sands to carry out evaluation of certain missile systems which might be adapted to Corps needs.

Tremendous Instrumentation Task

Instrumenting the variety of missiles presented by the missile range users is another job as overwhelming as the towering mountains that rim the range. The finest in electronic and optical devices probe every facet of a missile test from pre-launch checkouts to static tests to hot firings. For instance, a radar "chain" of five stations provides constant and continual surveillance, for instrumentation and safety reasons, on a missile launched at one end of the range and impacted at the other. Other precision radars, cameras like the Askania, telescopes such as IGOR and ROTI, and electronic

devices from dovap to telemetry—all linked to a central timing system—record data from launch to impact or intercept.

Since little American-developed equipment designed specifically for the missile program had been developed or even planned when White Sands was born in 1945, many of the early devices were locally produced and perfected.

Today this same application of local ingenuity to meet local problems is continued at the missile range. The first application of a dual-dovap system on adjacent radio frequencies to record individual data on two missiles fired two seconds apart was successfully planned and executed here. Similarly, a camera designed to instrument a missile from launch, first headon and then overhead to tailaway, all automatically, was designed and tested at White Sands; this camera, PROSAM (programmed single axis mount), has long been desired by missile scientists at WSMR and elsewhere to provide data records.

With the launching in early June 1958 of a Redstone ballistic missile at White Sands—the first of a series of inland firings of Redstone—WSMR instrumentation was stretched to increased heights. When Nike Zeus tests began in August 1959, the instrumentation reached out further.

Shortly after the inception of Zeus early test model firings, the missile range was allowed to extend its northern boundary to take in a 40-mile by 40-mile "safety zone" on a co-use basis for a maximum of 20 separate days a year. The 1,600-square-mile tract is leased on this part-time basis primarily for recovery of Zeus components but is utilized also by Nike Hercules, Redstone, and the Navy Talos. The extension agreement was achieved under conditions almost unprecedented. Within 60 days after the final Corps of Engineers survey had been made, all 32 families residing in the 40-by-40 ranchland and national forest area had agreed, without complaint, to leave their homes on 20 unspecified dates.

In the first days of the range, however, the former cattle empire forming much of the test center was bordered by still-operating ranches. Some situations encountered could not be so simply solved as was the land extension. The not-always-dependable V–2, for instance, was known to stray off the range in spite of safety measures taken. With ranches going full tilt in the vicinity, WSMR officials always viewed each off-range impact with trepidation; the closest call probably came the day recovery officers found a rancher staring in amazement at a crater some 50 yards away. That one worked out well, judging from their conversation:

"You fellas fire that thing?"

"Yes, sir. Was anyone injured?"

"Nope. You firin' any more?"

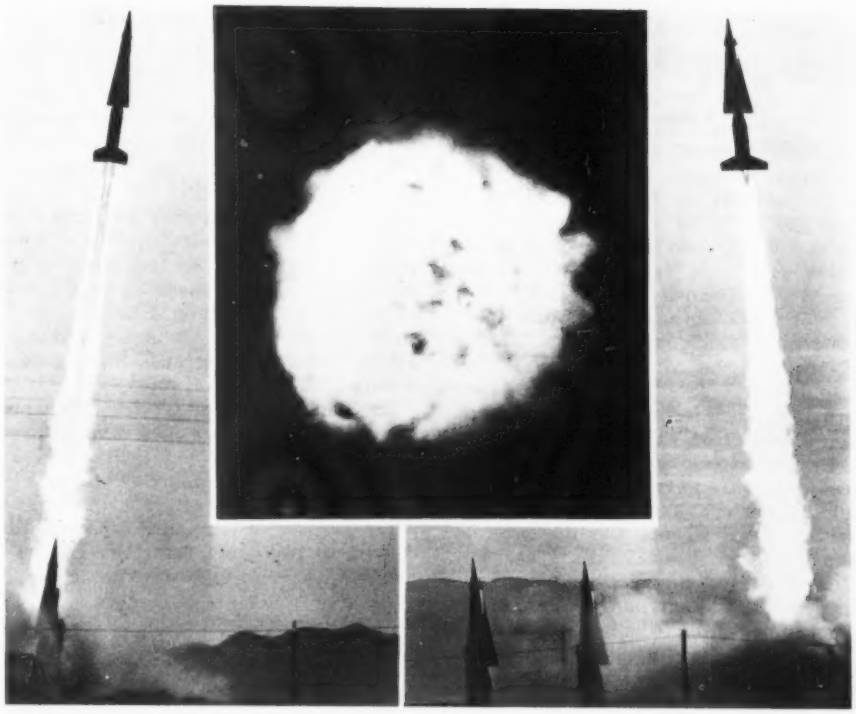
"There will be more, sir, but precautions will be taken to insure the missile impacts within the boundaries . . . ."

"How 'bout droppin' another one right over yonder. Makes the best damn water tank I ever seen."

But that conversation, perhaps not as accurate as it might be, is part of the history of White Sands Missile Range. Those were the years during which WSMR formed the trunk of the Army's family tree of missilry.

Today the trunk has branched, but those limbs are straight and are climbing upward. As today's tactical and strategic missiles reach perfection and then obsolescence, their development will to a greater or lesser extent be influenced by the continued activity at White Sands Missile Range.

Nike Hercules Intercepts Twin 19 Miles Above Earth



The U.S. Army's NIKE HERCULES, a forerunner of NIKE ZEUS, demonstrated capabilities at White Sands Missile Range in recent tests. One "killer" N–H destroyed its twin 19 miles above the earth at speed exceeding Mach 7.

New Field Diagnostic X-Ray Unit Weighs 85 Pounds

A compact diagnostic field X-ray unit weighing only 85 pounds has been developed by the Linfield Research Institute under contract with the Army Medical Service Research and Development Command.

To achieve results comparable with those of the new unit, supporting Army field hospitals, evacuation hospitals and Mobile Army Surgical Hospitals immediately behind combat divisions in the field have had to use a unit weighing approximately 1,000 pounds.

A working prototype of the self-powered clinical X-ray operates on rechargeable batteries. The device has the potential to provide the Army Medical Service and civilian doctors, for the first time, with a portable unit to take X-rays when electricity is not available, either in a combat zone or at the scene of a civilian accident.

Field medical units would find such a device of value in bedside use to locate metallic or other foreign bodies in wounds, in diagnosing fractures, and in the examination of certain internal organs. An outstanding feature of the unit is that it provides a diagnostic X-ray at such speed that it will not blur during chest radiography while the patient is breathing—particularly important for unconscious patients.

The device could also be used by civilian physicians who work in isolated areas under primitive conditions.

Defense Director (R&E) Approves VTOL Aircraft Program

The Director of Defense Research and Engineering recently announced the approval of a Tri-Service Program directed toward producing a prototype VTOL (Vertical Takeoff and Landing) transport aircraft for operational and technical research.

For several years, the Army, Navy, and Air Force have conducted projects in the VTOL field that have produced "test bed" type vehicles such as the Army's McDonnell XV–1, Bell XV–3, Vertol VZ–2, Ryan VZ–3, Doak VZ–4, Fairchild VZ–5; the Navy's Kaman K–16; and the Air Force's Bell X–14 and Hiller X–18. These vehicles have provided much technical information on the potential of VTOL aircraft.

Several extensive studies by the services and OSD have been made on the application of VTOL aircraft to meet service requirements and the forecast capabilities of future VTOL types. The United States aircraft industry has made a major contribution and investment in providing technical information for the Air Force SR 175 project and technical and operational analysis for the Army's Aircraft Requirement Review Board. The Perkins Committee, sponsored by the Office, Secretary of Defense, has provided a detailed review of the entire VTOL field.

Studies have made one point evident. The technical feasibility of the various approaches to VTOL aircraft has been thoroughly explored; however, the operational problems associated with these advanced types of aircraft remain highly speculative. Both the Perkins Committee and the Army Aircraft Requirements Review Board recognized this and recommended that Operational Research aircraft be developed to explore the operational problems such as effects of high downwash velocities, complexity of control, maintenance requirements and capability to operate under various conditions of flight.

The operational questions must be answered before realistic plans can be made and detailed requirements prepared by each of the three services for advance types of VTOL aircraft to perform specific missions.

A working group, reporting to the Assistant Secretaries of the Navy and the Air Force for R&D and the Director of R&D of the Army, has developed a program to produce the Operational Research aircraft. The group was chaired by Col Robert R. Williams of the Army. The Navy was represented by Capt H. H. Larsen and the Air Force by Col Joseph W. Howell. The program developed by the working group was endorsed by the Assistant Secretaries of the Navy and Air Force for R&D and the Director of R&D of the Army, and is incorporated in the plan approved by the DD (R&E).

The Department of the Navy has been designated as the service to conduct the program. Equal representation and participation by the three services is assured during all phases of development and test progress. The first step will be the initiation of a design competition based on type specifications being developed by the Navy in cooperation with the Army and Air Force. Joint program funding is assured.

In light of the Tri-Service program, the National Aeronautics and Space Administration (NASA) held a recent conference at the Langley Research Center on V/STOL aircraft. The primary purpose of the conference was to convey to personnel from the Department of Defense, industry and universities, the results of recent NASA research pertinent to low-to-moderate subsonic speed VTOL aircraft.

Twenty-six technical papers were presented by staff members of NASA Research Centers on aerodynamics, handling qualities, specialized problems of V/STOL operation and loads and structures. More than 300 delegates representing the United States, United Kingdom and Canadian defense establishments, U.S. and Canadian industry, U.S. universities and U.S. commercial aircraft users and Federal Aviation Agency were present, signifying the widespread interest in VTOL airplane research and development.

Mr. Charles H. Zimmerman, NASA Langley Research Center and a member of the Army Scientific Advisory Panel, presented the final paper summarizing V/STOL state-of-the-art. In conclusion, he stated:

"With the information now available it is possible to build V/STOL aircraft suitable for operational testing and evaluation and, probably with some modification, useful as service aircraft.

"A great deal of intensive research is still required to permit the construction of optimum V/STOL aircraft having greatest utility and productivity.

"In order that research may be properly guided and expended most productively toward the ultimate goal of practical, useful service aircraft, the type of information needed is that which can be obtained only from operational experience with V/STOL aircraft incorporating those features which, on the basis of present knowledge and engineering judgment, most nearly approach those which will finally be found most satisfactory.

"There is no reason to expect a breakthrough which will materially alter this situation. Design and construction should proceed now of the best aircraft which the state-of-the-art can produce."

Artist's conception of VTOL aircraft capable of rough terrain operations.

TC Symposium Weighs Many Problems Caused By Aircraft Downwash

Problems caused by the force of air created by rotors and propellers of aircraft taking off, landing, hovering or moving on the ground were discussed at a recent Downwash Impingement Symposium sponsored by the U.S. Transportation Research Command, Fort Eustis, Va.

The effect of downwash force on personnel, tentage and equipment in the proximity of an aircraft in the process of taking off or landing and resultant ground surface erosion were among primary problems considered. Others included downwash limitation of visibility of air and ground crew members when a landing is made in loose soil, sand or snow, the decrease in the lift capability of an aircraft when filters are clogged with loose particles of dirt or sand, and the increased maintenance required.

Presentations were made by representatives of governmental, industrial and military organizations, including the U.S. Army Aviation Board at Fort Rucker, Ala., the Wright Air Development Division at Wright Patterson Air Force Base, Ohio, Hiller Aircraft Corp. of Palo Alto, Calif., Cornell Aeronautical Laboratory and Bell Aerosystems Co. of Buffalo, N.Y., Boeing Airplane Co. of Seattle, Wash., Kellett Aircraft Corp. of Willow Grove, Pa., the National Aeronautics and Space Administration at Langley Field, Va., the Department of the Navy, the U.S. Army Engineer Waterways Experiment Station at Vicksburg, Miss., Lockheed Aircraft Corp. of Marietta, Ga., United Aircraft Corp. of Stratford, Conn., and the host organization, the Army Transportation Research Command.

National Alert Speeded Up

Less than 10 minutes are now required to alert the Nation in the event of a national emergency as a result of an agreement entered into recently by the U.S. Air Force, the Federal Communications Commission, the Associated Press and the United Press International.

Under the new system updating the CONELRAD alert system to the missile age, virtually every radio station in the Nation can be notified, through thousands of news wire service teletype machines, in three to eight minutes after it is determined by the Air Force that an enemy attack is likely or underway. The old alert system, using telephonic communications, required up to one hour.

Mother of 2 Children Holds QMFCI Award As "Man of Year" in Scientific Research

Can a mother of two children be designated a "Man of the Year" in scientific research? The answer is the same as for the question: "Can women succeed in Army science?" In both cases it is "Yes"—and Dr. Doris Howes Calloway has proved it.

A nutrition expert with the Army since 1951, Dr. Calloway received the "Man of the Year in Research" award in 1959 from the Quartermaster Food and Container Institute for the Armed Forces, Chicago. That same year she received the Army's Meritorious Civilian Service Award and the Department of the Army Certificate of Achievement.

Dr. Calloway is chief of the Nutrition Branch of the Institute. As such, her principal scientific interest is the relationship of food to military stresses, most recently radiation effects. Presently she is exploring the influence of nutrient intakes to learn whether certain foods may possess protective factors against radiation effects.

Mrs. Doris H. Calloway presented a prize-winning paper at Army Science Conference in 1959 and was recognized by Brig Gen William J. Ely, Director of Army Research. Her animal studies may reveal protective factors in foods which diminish stress.

In extensive experimentation with various animals she has observed that, with guinea pigs, supplementing a cereal diet with vegetables of the cabbage family has beneficial effects. She has noted two effects in particular: fewer die as a result of radiation and deaths occur at a later time. Dr. Calloway has also obtained results indicating that supplementing the diet with high levels of all the known vitamins can delay the death of exposed animals.

While still evaluating the implications of her voluminous data, Dr. Calloway is encouraged on the basis of experiments to date to believe that there are protective factors in certain foods, which will eventually be defined as chemical or biochemical substances.

Field Rations Involved

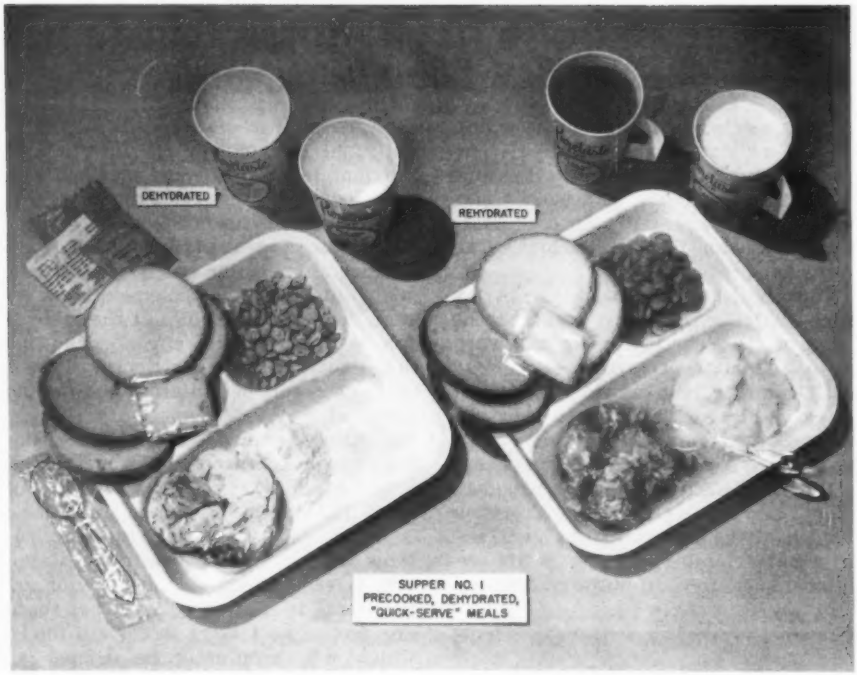
As chief of the Nutrition Branch, Dr. Calloway plans, directs, and coordinates a comprehensive basic and applied research program. An important purpose of the program is to assure the nutritional reliability of field rations. The relationship between field rations and performance capacity is among investigative responsibilities of the Branch.

A native of Ohio, Dr. Calloway received her B.S. degree from Ohio State University. Following supplementary training at the Johns Hopkins Hospital, Baltimore, Md., she studied at the University of Chicago, receiving her Ph. D. there in 1947. After serving as a University researcher and working as an independent consultant in therapeutic nutrition, she joined the Institute's Nutrition Branch.

Professional Affiliations

Dr. Calloway was elected to Sigma Xi, top scholastic society for science majors, at the University of Chicago in 1947. She is a Diplomate of the American Board of Nutrition, and a member of the American Institute of Nutrition, the Research Advisory Council. Institute of Poultry Industries, and the Department of Army Panel on Environmental Physiology.

Her outside interests are varied—first, her children, David Karl, 13, and Candace Mary, 12, who attend the noted University of Chicago "lab" school near their home; the Campfire Girls (she is a council member), interior decorating (she finishes her own furniture), cookery (she likes to prepare exotic dishes), and the theater (she favors ballet).



Precooked and dehydrated foods are nourishing, quickly prepared in field.

QM Plans Dehydrated Foods Field Tests

Dehydrated rations have been developed to the point where they will be field tested by the Quartermaster Corps this spring. Twenty-one different menus will be tested.

With the dehydrates, the man in the field can start his breakfast with a juice—orange, grapefruit, or tomato—or prepare a complete hot meal in a matter of 30 minutes.

Dehydrated rations designed by the Quartermaster Food and Container Institute for the Armed Forces, QM Research and Engineering Command, have simplified the handling of field rations and reduced costs. Research, development and engineering have provided precooked dehydrated foods which, composed into a menu, come as close to an "instant meal" as it is currently possible to obtain. "Quick Serve Meals" tie in with the new logistical and combat concepts.

A food preservation method dating back to antiquity, dehydration or drying is fast becoming the "newest" development in the food industry today. Quartermaster Corps research has been an important stimulus to modern industry applications. New and improved methods of dehydration, such as freeze drying, have resulted in products that are highly acceptable in color, odor, flavor, and texture. But it has taken intensive product study (each item differs) and ingenious engineering to bring this about.

Armed Forces interest in dehydrated foods stems from well-recognized logistical advantages—low weight and low space requirements. The precooked dehydrated meals to be provided the Army in warfare of the future will give combat forces variety, a better level of acceptability and an optimal ease and speed of use never before achieved. Operational feeding in the future will be keyed to "instant" foods.

Research Objectives

Quartermaster research on dehydration is devoted to accelerating the speed of water removal, which is easy at first, difficult in the final stages, and to the retention of the original flavor and texture qualities of a product.

Dehydrated food has a great advantage over other types of preserved food. It permits the use of flexible packaging instead of metal cans or glass bottles, reducing the tare weight of packaged subsistence substantially. Much work has gone into the design of flexible packaging, for example, the development of laminates that are proof against rough handling and the ravages of heat, cold, and moisture.

Flexible packages for dehydrated foods have been a gain for logistics, but at the same time have created problems. Dehydrates must be protected from moisture-vapor and gases. Packaging must also be rigid enough to prevent crushing the fragile dehydrated foods which they contain. During shipment and handling, roast beef would soon become pulverized beef without adequate package rigidity. The package must also be strong enough to prevent puncturing by the sharp edges of some of the dehydrates—for example, dehydrated carrots.

New Container Developed

To meet these varied problems and also that of utility in fast moving military operations, QMC packaging technologists have developed a novel container. It consists of a flexible film-foil laminated bag which is placed within a cardboard carton. The cartons have an expandable feature which allows direct addition of water for reconstitution of the product in the field. This dual-purpose package represents a significant contribution to speeding up field feeding operations.

Increasingly interesting to the food industry is the remarkable potential of freeze-dehydration, and it appears that a commercial breakthrough is at hand. In this process, the food is quick frozen, placed in a vacuum chamber, and dehydrated at low temperature. Using freeze-drying, the Quartermaster Corps has found it possible to dehydrate such highly desired foods as steaks and chops, which have presented discouraging problems using conventional dehydration methods. Freeze-drying yields a product that retains its structure. A steak actually looks and tastes like a steak.

Foods Under Study

Latest freeze-dried items under study at the QM Food and Container Institute for the Armed Forces include french fried fish cakes, scrambled eggs, and cottage cheese. The fish cakes retain a crisp shell upon rehydration—a signal accomplishment in dehydration. The eggs are highly acceptable, far exceeding any breakfast egg product prepared from the present dried eggs in the military subsistence system. The cottage cheese promises to supply in field situations remote from refrigeration facilities a well-liked item of high stability. This product is highly perishable in the fresh state.

Quartermaster Corps research efforts are coordinated with food industry potentials and are now leading to the development of feeding systems, such as the quick-serve meals, which will meet the needs of the modern mobile army. If these meals seem to be rather a far cry from the austere "hardtack and bully beef" of yesterday, remember that for combat soldiers of the future optimal nutrition is not a luxury. It is a prime necessity.

TC Drivers Travel Roads Leading Nowhere, Equal 690 Trips Around World

On and on and on they drove, a total of 17,000,000 miles—equal to 690 trips around the world—and got nowhere.

They were 1,250 soldiers of the U.S. Army Transportation Corps Road Test Support Activity under command of Lt Col Richard J. Lombard, who amassed their mileage on five test turnpikes of concrete and asphalt in support of the American Association of State Highway Officials highway research project near Ottawa, Ill.

For 25½ months, beginning Oct. 15, 1958, the soldiers drove 100 concrete-loaded test vehicles ranging from small pick-ups with a half-ton load up to huge semitractor and trailer combinations with a gross weight of 54 tons.

During their long, monotonous journey, none of the soldier-drivers got farther than 10 miles from their barracks. Their route took them around five 2-lane test loops 3.15 miles in circumference.

Rigid Driving Conditions

The soldiers rolled 20 trucks per loop, 10 per test lane, 19 hours out of every 24. Holding to rigidly controlled patterns, at speeds not over 35 or less than 25 miles an hour, they drove in daylight and darkness, rain, snow and sleet, through cold and heat—without encountering pedestrians, traffic lights, or cross traffic. Their only change of scenery was experienced at sunrise and sunset, and with changing seasons.

The driving consumed 894,000 man-hours, 3,853,000 gallons of gasoline and diesel fuel. The trucks accomplished 310 million ton-miles of operation.

The grueling test served a double purpose. As a scientific study of highways subjected to heavy truck traffic, it will provide data required by engineers in the construction of highways of the future, highways that would be vitally needed to support national defense in event of a major emergency.

During the final year of the run, the soldier-drivers became subjects for research into the human factors of fatigue and monotony. This research program, implemented by the Transportation Corps in conjunction with the Personnel Research Board of the Army (AG), was geared to study men's work environment as it affects dependability of job performance.

Leadership Clarified

Of the second-rate rulers, people speak respectfully saying, "He has done this, he had done that." Of the first-rate rulers they do not say this. They say, "we have done it all ourselves."
—Lao-tze

CmlC Volunteers Test Protective Gear

Nineteen medical research volunteers at the U.S. Army Chemical Center, Md., recently wore masks, hoods, and other chemical protective gear for 72 hours in a simulated combat situation.

Physiological studies of the men, during and after the test, showed that the fit of the new standard M17 field protective mask permits it to be worn for long periods of time without facial distress. The volunteers reported they quickly became accustomed to both the mask and protective hood, and said they experienced no undue discomfort.

The field test was conducted by the U.S. Army Chemical Research and Development Laboratories' Directorate of Medical Research, in conjunction with the U.S. Army Chemical Corps Board. Supervising the exercise were Dr. E. G. Cummings of the Laboratories' Applied Physiology Branch and Majors John Marrero and Eugene K. Bird of the Chemical Corps Board.

The Board's participation was a step in Chemical Corps Combat Development Project "Field Experiment of Operations in CW Contaminated Areas."

The obvious problem of feeding the field soldier during prolonged exposure to toxic chemicals was explored by using such experimental items as a feeding-drinking tube attached to the mask.

An experimental feeding station, a large, boxlike tent with pressurized ventilation, enabled the volunteers to be fed canned rations in the field. Thrusting heads into the tent through elastic openings, and running their hands into sleeved holes, the men removed masks, hoods and gloves to eat C-rations inside the facility while seated outside.

In a simulated toxic atmosphere for 72 hours, 19 Medical research volunteers wore masks and protective clothing, ate C-rations inside but seated outside.

Col Beverley Assigned Assistant Director of Army Research

Col William W. Beverley, Artillery, who recently joined the Office of the Chief of Research and Development, has been assigned as Assistant Director, Army Research Office.

Col Beverley graduated from the United States Military Academy in 1938. He is a graduate of the U.S.A. Artillery and Missile School, U.S.A. Armor School, U.S.A. Command and General Staff College, Armed Forces Staff College, U.S. Army War College.

His previous assignments have included duty as: Armored Artillery Battalion Commander, European Theater, 1942–47; Division Chief, Office of Assistant Chief of Staff, Intelligence, 1951–54; Chief of Army Section, American Military Assistance Staff, Yugoslavia, 1955–57; Commander, Artillery Group (SS missiles), 1958–59; and Director of Combat Developments and Doctrine, USA Artillery and Missile School, 1959–60.

Col and Mrs. Beverley reside at 308 Lamond Place, Alexandria, Virginia.

ERDL 40-Year Veteran Earns High Award

Colonel Kerkering presents Meritorious Civilian Service Award to Mr. Wilson.

Howard Wilson, who completed 40 years of Government service before his retirement last month at the U.S. Army Engineer Research and Development Laboratories, Fort Belvoir, Va., closed his career by receiving the Meritorious Civilian Service Award.

Col John H. Kerkering, Director of ERDL, presented the award, one of the highest honors that can be won by U.S. Government civilian employees. The award included a pin and a Department of the Army certificate.

Signed by Lt Gen E. C. Itschner, Chief of Engineers, the citation stated, in part, that Mr. Wilson had shown "exceptional initiative, perseverance, and ability in the field of vehicular design and his many contributions to the development of special purpose vehicles for the Corps of Engineers and general purpose trailers and vehicular bodies for the Army . . . In his outstanding devotion to duty, he has personified those high qualities most desirable in a civil servant."

Mr. Wilson served at ERDL successively as Chief, Transportation Design Section; Chief, Special Vehicles Section; Chief, Special Purpose Equipment Branch, and as Head, Research Engineering Group, all within the Mechanical Department. Prior to transferring to the Laboratories at Fort Belvoir in 1940, he had been employed by the U.S. Department of Commerce, Department of State, Department of Agriculture, and the District of Columbia Government.

ERDL Presents 3 Superior Performance Awards

Three civilian employees and one enlisted man at the U.S. Army Engineer Research and Development Laboratories, Fort Belvoir, Va., recently received awards in recognition of their work.

Col John H. Kerkering, Director, presented the awards to Mrs. Esther S. Pitzer, Fredericksburg, Va., Arthur Berreth, Annandale, Va., Joseph E. Courtney Jr., Arlington, Va., and M/Sgt Herbert H. Stoltenberg, Fort Belvoir.

Mrs. Pitzer, Mr. Berreth, and Mr. Courtney were the recipients of "Sustained Superior Performance" awards. Mrs. Pitzer, employed in the Specifications and Reports Branch, and Mr. Courtney, employed in Packaging Development Branch, received cash awards of $100 each in addition to Department of the Army certificates. Mr. Berreth received $200 and a certificate in recognition of his work as chief of the Property Accounting Branch.

M/Sgt Stoltenberg received a certificate, a cash award of $15, and a 3-day pass as second prize for the enlisted men's adopted suggestion at Fort Belvoir. He suggested a review of parts supply be furnished with test items, a procedure that will save an estimated $18,000 yearly in operational costs.

Seventh Army Testing MOBIDIC Computer

Use by the Seventh Army in Europe of the first large-scale mobile computer especially made to support the Army's tactical striking forces marks a major move by the Army in its plan to automate many combat operations and combat support computations in fire support, surveillance, intelligence, logistics and administration.

Decision to send the high-speed, large capacity military computer to Europe was announced after it was exhibited at the Eastern Joint Computer Conference in New York City. In its 30-foot Army trailer MOBIDIC (Mobile Digital Computer) can move on the ground or be transported by air.

"Advancements in technology have so speeded up the processes of modern warfare that time has become a most precious commodity," stated Brig Gen John C. Monahan, Chief of the Army Signal Corps Research and Development Division. "Future commanders must take advantage of all new techniques and devices to provide them with timely information. MOBIDIC is the first and largest of the FIELDATA family and represents a major move in our efforts to apply the techniques of automation to battlefield operations."

The mobile computer was developed under the technical direction of the U.S. Army Signal Research and Development Laboratory at Fort Monmouth, N.J., by Sylvania Electric Products, Inc., a subsidiary of General Telephone and Electronics Corp.

TC Team Tests Tactics In Panamanian Jungle

Men and transportation technology were pitted against the Panama jungle in the opening phases of Operation Tropical Wet, a research and test project of the Transportation Environmental Operations Group (TREOG).

The test began in November when a team of military and civilian scientists left Fort Kobbe in the Canal Zone for their jump-off point into the jungle near Chepo, Republic of Panama. Prime purpose of the project was to test the ability of a unit to penetrate jungle and tropical terrain without special engineer equipment or support.

Other test missions included:

The role of the amphibian vehicle in tropical waterways; Army aviation resupply and evacuation techniques in support of ground forces in the tropics; surface and aerial navigation techniques; environmental tests of the Army's new Rolling Liquid Transporter; and feasibility trials of the new Rolli-Trailer 3-ton cargo vehicle.

Engineers Develop Portable Bridge Hoist Cylinder

Designed especially to help hoist into operating position the armored vehicle-launched "scissors" bridge under conditions calling for continuous and rugged usage, a new type of hydraulic cylinder has been developed and successfully proof-tested at the Engineer Research and Development Laboratories, Fort Belvoir, Va.

Constructed of aluminum alloy, the "scissors" bridge is carried in a folded position by a turret-less tank to within a few feet of a gap to be spanned. Hydraulic cylinders raise the bridge until it is perpendicular to the ground. As it is lowered forward it unfolds to its extended position, in which it can span a 60-foot gap.

The need of a special cylinder capable of satisfactory performance under 3,500-pound pressure per square inch (p.s.i.) became manifest when extended field usage of the bridge showed that a commercial tie-rod cylinder was inadequate and created maintenance difficulties. The new cylinder uses caps that are screwed into the cylinder tube.

The cylinders developed by ERDL were statically proof-tested to 7,000-pound pressure p.s.i. without evidence of leakage, and were still in excellent condition after 750 launchings and retrievings of the 63-foot bridge. ERDL also developed the "scissors" bridge.

Armored Vehicle Launched "scissors" bridge; 3 new launch cylinders shown.

CmlC Scientists Present 22 Papers at Meeting

Chemical Corps scientists presented 22 research and development papers at the recent 53d annual meeting of the American Institute of Chemical Engineers in Washington, D.C. The presiding chairman at two sessions was Mr. E. L. Garono, U.S. Army Chemical Corps Engineering Command (ENCOM).

Papers included: Recent Dispersion Equipment Developments, R. L. Brown, Jr., ENCOM; Free Fall Break-up of a Liquid Mass, A. B. Palmer, J. D. Wilcox and J. V. Pistritto, U.S. Army Chemical Research and Development Laboratories (CRDL); A Study of the Factors Influencing the Flashing of Liquid Aerosols, J. V. Pistritto and J. D. Wilcox; Some Technical Problems in the Generation of Aerosols for Inhalation Studies, and Some Considerations in Wind Tunnel Studies of Aerosols, C. L. Punte and E. J. Owens, CRDL.

The Aerosol and Spray Fall-Out Meter, R. D. Kracke and A. Pfeiffer, CRDL; The Measurement of the Properties and Parameters of Small Particle Aerosols in Cloud Chambers, E. W. Larson, Chemical Corps Biological Laboratories; A Preliminary Theoretical Study of The Cloud Travel of Coarse Aerosol Particles, D. O. Egner, D. Campbell, R. L. Campbell and J. S. Tyler, Jr., CRDL.

Development of a Chemiluminescent Sampler which determines the concentration of oxidants in the air or in liquid flow systems was discussed by R. L. Wilburn, J. H. Fronk and G. W. Wooten of the U.S. Army Chemical Corps Proving Ground, Dugway, Utah.

Papers presented during the two sessions on toxic plant construction were: Toxic Pre-Pilot Plant Processing, S. R. Eckhaus, CRDL; Design of Pilot Plants for Toxic Chemicals, A. B. Rhodes and J. C. Richards, CRDL; Heating and Ventilating for Toxic Chemical Plants, E. T. Rock, ENCOM; Some Requirements for Housing, Ventilating, and Certain Service Systems for a Toxic Biological Facility, G. R. Holt, Jr., U.S. Army Chemical Arsenal, Pine Bluff, Ark.; Engineering Safety in the Design of Toxic Chemical Plants, J. W. Kenney, U.S. Army Chemical Arsenal, Rocky Mountain Arsenal, Colo.; Engineering Safety in the Design of Toxic Filling Plants, W. B. Keene (deceased) and M. G. Ringenberg, CRDL; Construction and Operation of Toxic Chemical Pilot Plants, B. A. Hildebrand and G. T. Woodward, CRDL; Corrosion Problems in a Nerve Agent Plant, L. W. Bonifield, Rocky Mountain Arsenal; Corrosion Inhibitors and Coatings for Toxic Biological Facilities, T. E. Shook and G. R. Holt, Jr., Pine Bluff Arsenal.

Lt Col S. Tonetti, U.S. Army Chemical Corps Materiel Command, described the history of the Phosphate Development Works at Muscle Shoals, Ala., and the function of this facility in support of the Chemical Corps program.

Armed Forces Building Radiobiology Institute

Opportunity to carry out a broad research program dealing with effects of radiation will be provided to scientists of the Army, Navy and Air Force with completion of the Armed Forces Radiobiology Research Institute, National Naval Medical Center, Bethesda, Md.

The Institute will include a Department of Defense nuclear reactor facility under the sponsorship of the Defense Atomic Support Agency. This will be the first pulse type reactor designed solely for medical research, with laboratory control of radiation dosage.

The General Dynamics Corporation, San Diego, Calif., will build the facility at a cost of approximately $2.4 million. Completion date is October 1961.

Newsmagazine Soliciting Cartoons Regarding R&D

Cartoonists who believe they can provide a welcome touch of humor to the contents of the *Army Research and Development Newsmagazine* are invited to submit samples of their work.

Cartoons offered for publication must be in good taste and pertinent to Army research and development activities or to problems, particularly those of a morale and welfare nature, of wide interest to the more than 25,000 scientists and engineers in Army laboratories.

No compensation can be paid for cartoons accepted for publication. Contributors may identify their work by placing their name or initials on each submission. Cartoons should be submitted through the appropriate post or installation Technical Liaison Office or Public Information Officer to the Editor, *Army Research and Development Newsmagazine*, Army Research Office, OCRD, Department of Army, Washington, D.C.

What's this I hear about your discovering something new in ground effects phenomena, Doctor?

QM Clothing Research Goal: Protect Soldier in Any Climate

By Dr. S. J. Kennedy, Chief, Textile, Clothing & Footwear Division, U.S. Army Quartermaster Research and Engineering Center

The protection of the individual soldier has many aspects. All of the Technical Services contribute to it in some way or other. Strengthening of the soldier's offensive power is, of course, one form of protection.

The task of the Quartermaster Corps in the field of protection is, however, related specifically to the physiological and psychological responses of the soldier to the battlefield. It is concerned with providing positive protection to the individual against the factors of the natural and enemy-imposed environment, as well as making positive contributions toward augmenting his physical efficiency and maintaining high morale.

In this task, the Quartermaster Corps mission is most closely related to that of the Army Medical Service, except that we are concerned primarily with the *well* soldier, the man whose brain and brawn we rely upon for victory.

We seek to protect and augment the soldier's combat efficiency in the food, clothing, and personal equipment we furnish him. What we give him can, in a positive sense, help keep him well. It can help reduce the drain on his physical energy, help lessen battlefield fatigue, and, in short, give him a corresponding edge over the enemy.

Functional Components

The soldier's clothing and equipment system is composed of five separate functional components:

1. The outer "shield" of his clothing system, upon which impinges all of the external environmental forces, both natural and enemy-imposed.
2. The insulating or spacing layers, which provide dead air space or which keep the shield fabric away from the body to prevent transfer of high-intensity energy to the body surface.
3. Body layers—the underwear.
4. The load-carrying system—the harness worn over the clothing and various appended items of equipment.
5. The armor layer—the layer of fabrics used to stop projectiles, worn over one or more of the other layers.

In developing clothing and equipment composed of one or more of these functional components, it is important for us to keep in mind the four-dimensional environment in which the soldier lives and fights: the climatic environment; his immediate physical environment; his psychological environment; and the environment imposed by the enemy.

The impact of these environmental factors does not differ too greatly, so far as our equipment is concerned, from equipment produced by the other Technical Services. However, there is one essential difference: we are dealing with items that must be directly related to the man's physiological processes. The impact of this problem shows up in dealing with all four environments, but is particularly critical in the climatic environment. It is also a limiting factor on the amount of protection that can be provided, particularly against factors of the enemy-imposed environment because of the direct physiological stress imposed on the soldier by each added increment of weight or restriction on his freedom of movement.

The combat soldier requires maximum in protective clothing that allows freedom of action. Here a WW II sergeant hauls supplies in the Arctic.

In the *climatic environment* we are concerned primarily with the three factors of effective temperature determined in terms of dry bulb and wet bulb temperatures, together with the amount of radiation, plus precipitation, and wind. We must be prepared to assist the soldier in carrying out his combat missions over a temperature range spanning 190° F. degrees of temperature, from plus 125° to minus 65° F., while the body itself is exerting all of its physiological processes to maintain a body temperature of 98.6°. That means in cold climates we must provide a clothing system which will minimize heat loss from the body. In hot climates we must shield the man from external radiant energy and assist him positively in the use of his body-cooling mechanism, thereby helping him to get rid of body heat through clothing.

The most effective way to prevent the loss of body heat in cold climates is to keep water out of his clothing system, because moisture reduces the insulating value of the clothing system.

Insofar as the problem of external moisture is concerned, we have an effective shield in the outer fabric of the clothing system. Here we use a tightly woven and water-repellent-treated fabric. Since the development here in our Quartermaster R&E Center Laboratories of the remarkable *Quarpel* water-repellent treatment, we can now provide the soldier with a completely water-repellent outer shield while retaining the functional property of water-vapor permeability which will allow his body moisture to pass freely through the fabric.

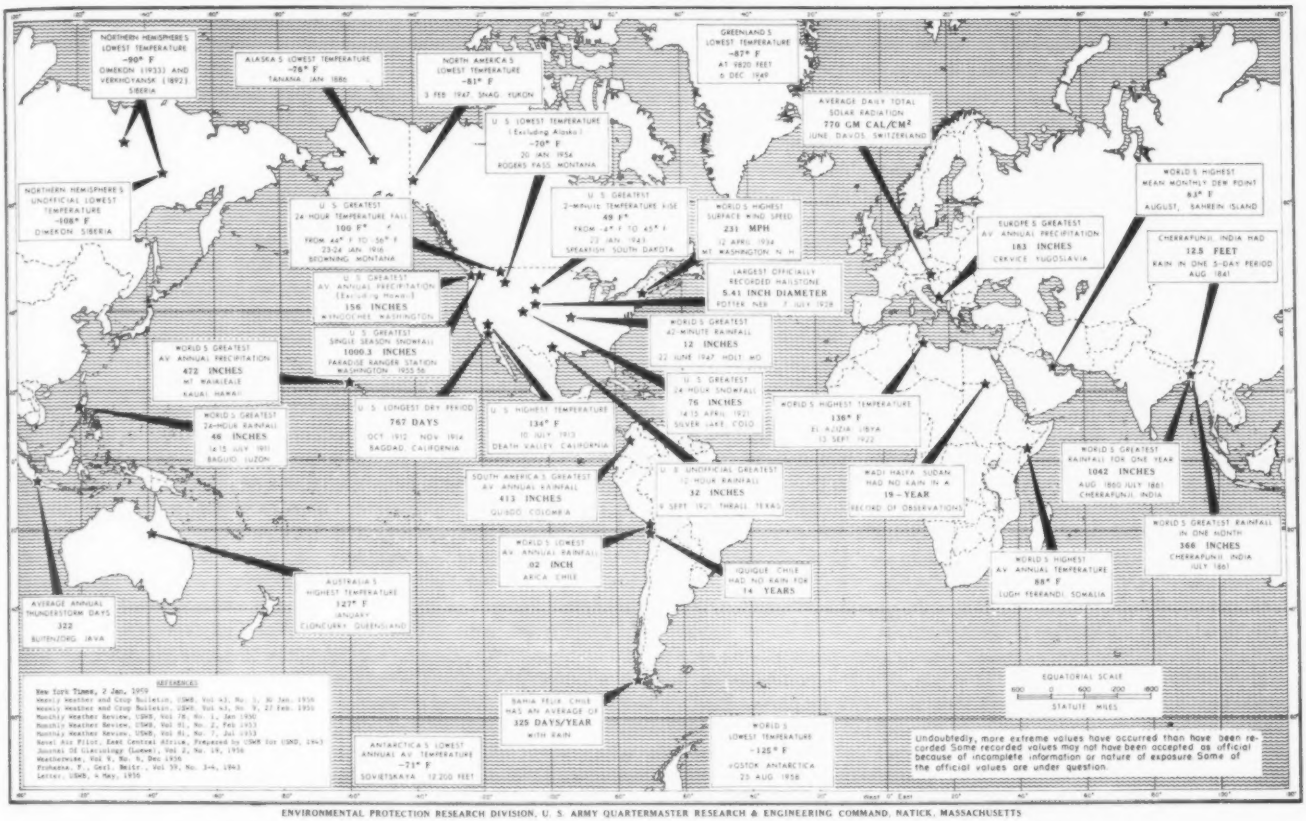
Layer System Flexibility

The second, and today the more difficult problem, is to deal with body moisture and its effect upon the soldier's microenvironment. By using a layer system of clothing which will enable the soldier to remove layers not needed at a given time over the 133° range which the cold-climate clothing must cover, we give him needed flexibility. In addition, by providing for effective ventilation of the clothing, we attempt to compensate for the tremendous range in activity levels with their concomitant production of body heat, ranging from such high activity levels as running to complete inactivity for several hours. Thus, at minus 20° F. he needs three times as much insulation when resting as when working.

From this standpoint, the system must be capable of allowing the soldier to dispose of .75 liter of body moisture per hour without any large amount of it accumulating in the clothing system. I should perhaps add that proper training is required for men to know how to use their combat clothing as it was designed. This is difficult to achieve among men who have worn clothing all their lives and who are sure that they know all about it, including how it should be designed!

A major step forward in providing a more efficient clothing system for cold environments was achieved during World War II by Dr. Paul Siple and Dr. L. W. Bazett in developing the principle of sealed insulation, which has since been adopted in our cold-climate footgear. Under this principle, the insulation surrounding the feet is sealed off from both external and internal moisture so that it cannot lose its insulating value, and with the feet

WEATHER EXTREMES AROUND THE WORLD



ENVIRONMENTAL PROTECTION RESEARCH DIVISION, U. S. ARMY QUARTERMASTER RESEARCH & ENGINEERING COMMAND, NATICK, MASSACHUSETTS

kept in a closed area free from contact with external moisture.

In both our black (cold-wet) and our white (cold-dry) insulated boots, this principle has reduced the problem of cold injury to the feet to insignificant proportions; protection for the hands is presently undergoing study, but the system must be modified if we are to retain dexterity and tactility of the fingers. It also has been considered for body clothing, but a suitable material has not yet become available for development of a satisfactory garment.

Auxiliary heating of the hands and feet for inactive men exposed under extreme cold or high windchill conditions, such as crews of mobile weapons, is an approach that can carry them through limited periods of high exposure if a power source can be made available, either from the vehicle or from rechargeable batteries.

Protection of the face area still remains the most difficult unsolved problem which confronts us in cold climates, particularly where there is a high windchill factor. In fact, the whole spatial configuration of the head, face, and neck area, with the need for retaining adequate sensory perception, and complete mobility, presents a very complex and difficult problem. The only practical approach is to determine how much one can afford to pay in reduction of efficiency for a given amount of protection.

Hot Climate Difficulties

Our most difficult protection problems arise in the hot climates. Once we have provided a shield to protect the man against gaining heat from the sun and from the hot winds in the desert, everything we add to his clothing system adds to his physiological stress. From a design standpoint, the most effective solution is a vented, loose-fitting system of clothing made from an absorptive, permeable fabric which will provide a chimney effect along the body surface that will be effective for evaporative cooling. A very thin, lightweight fabric, woven tightly enough to prevent mosquitoes and other arthropods from biting through it, is clearly needed. The soldier's clothing in hot climates must be capable of assisting the body to use up to 1.5 liters of body moisture per hour for effective cooling.

The *immediate physical environment of the soldier* is composed of the things in the soldier's natural environment other than the factors of climate. Actually, the requirements of the physical environment are the most severe to meet of any in the natural environments since they require providing a clothing system capable of giving nine months of service life. *How difficult it is to meet this will be evident when one considers that the physical environment includes the ground on which he walks, crawls, and sleeps: sharp wind-eroded rocks and sand; the alkali dust and sand storms of the desert; the mud resulting from rains and the ooze of bogs and swamps; the ice and the boulders on the slopes of mountains and in the Arctic; the sharp 6-inch thorns of the black palm; and the saw-edged kunai and elephant grasses that grow up to 12 feet high in tropical areas.*

Fortunately, achievements in textile materials engineering have shown ways to weave fabrics, to achieve the utmost in toughness and resistance to tearing and abrasion. Some of the new synthetic fibers have unusual strength and abrasion resistance; though it has not been possible to employ them up to this time because of their poor thermal properties when exposed to high-intensity thermal radiation, recent experimental work conducted in Quartermaster Corps laboratories has shown that we can get a synergistic effect in respect to thermal radiation by combining nylon with cotton. This has opened up the possibility of using this fiber in our shield fabrics to provide extra durability under combat conditions, as well as to yield extra thermal protection.

An interesting illustration of what can be done to provide greatly increased service life is that of our direct molded sole type of footgear. Tests indicate that it is actually possible to wear out the uppers of such shoes before the sole construction wears out. This comes near to giving us the "one-horse-shay" principle, our ultimate objective.

MEND Conferees Hear Presentations Regarding C–B Weapons Defense

Defense against chemical and biological weapons was the subject of the recent Medical Education for National Defense (MEND) symposium held at the Walter Reed Army Medical Center. MEND, a program to extend the teachings of military and disaster medicine in the undergraduate medical schools, conducts several symposia each year.

Chemical Corps scientists and Medical officers, engaged in Chemical Corps research projects, joined Army doctors from WRAMC in presenting a comprehensive picture of chemical and biological weapons capabilities, defense and treatment to almost 200 MEND representatives from medical schools throughout the country.

After a welcome by Maj. Gen. C. F. St. John, Commanding General, WRAMC, the group heard an introduction to defensive problems by Col William D. Tigertt, MC, Commanding Officer of the WRAMC Medical Unit at Fort Detrick, Md. Dr. LeRoy D. Fothergill, Scientific Advisor, U.S. Army Chemical Corps Biological Laboratories, Fort Detrick, lectured on the general concepts of using of biological weapons.

Other subjects discussed included:

Characteristics of Biological Aerosols—Dr. Robert J. Goodlow, Director of Biological Research, CmlC Biological Laboratories.

Physical Protection—Dr. Charles R. Phillips, Chief, Physical Defense Division, CmlC Biological Laboratories.

Characteristics of Respiratory Induced Disease—Col Tiggertt.

Current Capabilities for Defense—Col Dan Crozier, MC, Chief Medical Consultant, Professional Division, Office of The Surgeon General.

Trends in Methods of Identification—Lt Col Slater M. Dozier, MC, Deputy Commander, WRAMC Medical Unit, Fort Detrick.

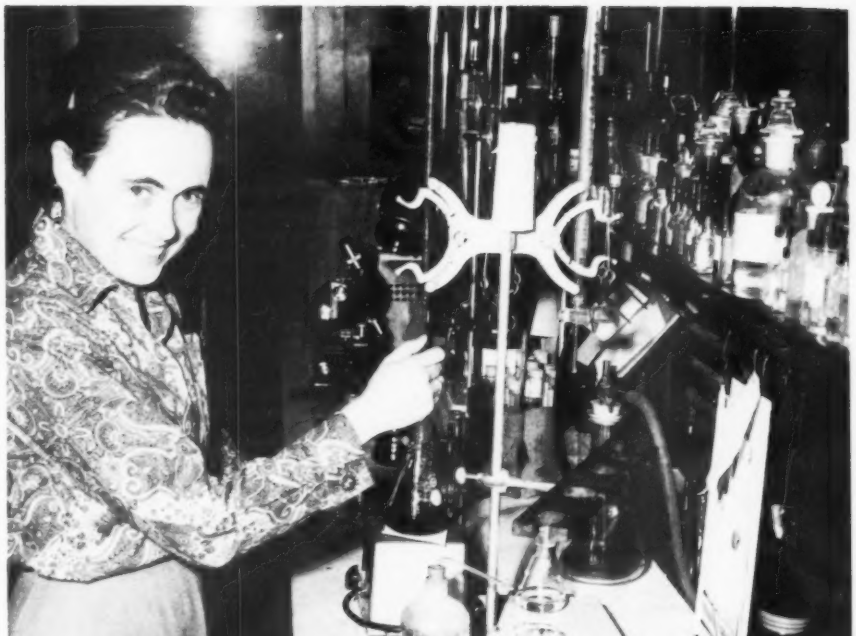
General Concepts of Chemical Weapons in Warfare—Col Douglas Lindsey, MC, Director, Medical Research, Army Chemical Center, Maryland.

Anti-cholinesterase Agents—Dr. Bernard P. McNamara, Chief, Toxicology Division, Directorate of Medical Research, U.S. Army Chemical Research and Development Laboratories (CRDL).

Psychological Incapacitation—Capt Malcolm Bowers, MC, Acting Chief, Surgical Research Branch, U.S. Army Medical R&D Command, OSG.

Two members of the Biophysics Division, Directorate of Medical Research, CRDL also lectured at the meeting: Maj Janice Mendelsohn, MC, Chief Trauma Investigations Branch, on "Surgical Implications of Recent Advances in Wound Ballistics" and Capt Dale R. Snyder, MC, Wound Ballistics Branch, on "Some Fundamental Considerations of Wound Ballistics."

The symposium concluded with a talk by Dr. Frank B. Berry, Assistant Secretary of Defense (Health and Medical) on "Nutrition Surveys and the People-to-People Program."



Miss Martha L. Adams.

Miss Adams Claims Unusual Distinction at APG Lab

Believed the only woman chemist of her kind in U.S. Government service, Miss Martha L. Adams of Baltimore, Md., works in the only Army laboratory of its kind.

In the chemical, cleaning and corrosion branch of the Army Ordnance Corps' Coating and Chemical Laboratory, Aberdeen Proving Ground, Md., she develops new methods of analysis for coating and chemical ingredients.

Methods developed by Miss Adams are used throughout the Laboratory in conducting basic and supporting research and basic production engineering investigations in coating and chemical fields. The only woman performing extensive research and development studies at the Laboratory, Miss Adams helps to provide the U.S. Government with information for future procurement of vital supplies.

Miss Adams was born in Springfield, Ill. Her father, R. C. Adams, is a civilian chemical engineer with the U.S. Navy. She received a B.S. degree from the College of William and Mary, Williamsburg, Va., and an M.S. degree from the University of Maryland, where she taught graduate and laboratory courses from 1948 to 1951. She has worked with the Coating and Chemical Laboratory since 1951.

The Laboratory comprises three branches: chemical, cleaning, and corrosion; paint, varnish and lacquer; and automotive and chemical packing. Together, these make up a research and development organization unparalleled within the Army in the combined fields of automotive chemicals, organic coatings, conversion coatings and cleaners.

Each branch of the Laboratory functions for a separate purpose: chemical, cleaning and corrosion, to conduct research and production engineering investigations of chemical cleaners and related components; paint, varnish and lacquer, to conduct the same type of work on organic and conversion coatings and related components; and automotive and chemical, to conduct similar research and production engineering investigations on automotive chemicals and strippable organic coatings and related components.

The Laboratory makes tests, on a global basis, for evaluations of coatings and chemicals, such as arctic-type hydraulic brake fluids, automotive coolents, shock absorbers, and organic coatings.

Talking About Weather Did You Know That. . .

Here are some meteorological tidbits to enliven the conversation at the next cocktail party, opening with the gambit: Did you know that . . .

The largest officially recorded hailstone fell at Potter, Nev.: It measured 5.41 inches in diameter.

The world's highest wind speed was recorded at Mt. Washington, N.H.: 231 m.p.h.

The greatest temperature fall in a 24-hour period occurred at Browning, Mont. The drop was from 44° F. to −56° F., a 100° fall. Going in the other direction, in a 2-minute temperature change at Spearfish, S. Dak., the mercury went from −4° F. to 45° F.

The lowest U.S. temperature (excluding Alaska) was recorded at Rogers Pass, Mont.: It got down to −70° F. Alaska's lowest is −76° F. BUT the world's lowest temperature was reported at Vostok, Antarctica: −125° F.

The highest U.S. temperature, 134° F., was recorded at Death Valley, Calif. The world's highest was reported at El Azizia, Libya: 136° F.

The longest U.S. dry period lasted 767 days, at Bagdad, Calif. BUT Wadi Halfa, Sudan, had no rain in a 19-year record of observation. Curiously, Bahia Felix, in southern Chile, has an average of 325 days in the year with rain, while Iquique, to the north in Chile, had no rain for 14 years.

The greatest U.S. average precipitation (excluding Hawaii) is 156 inches, at Wynoochee, Wash. The world's greatest average annual precipitation is 472 inches, recorded in Hawaii. BUT Cherrapunji, India, boasts these three rainfall records: 12.5 feet in a 5-day period; the world's greatest rainfall for 1 month, 366 inches; and the world's greatest for 1 year, 1,042 inches.

A map showing these weather records, and numerous others, has been drafted by scientists in the Environmental Protection Research Division of the Quartermaster Research and Engineering Laboratories. (*See page 13*).

Named WSMR Chief of Staff

In a streamlining of command operations, Brig Gen John G. Shinkle, Commanding General, White Sands Missile Range, has named Col Milton H. Clark, formerly chief of Mission Plans and Operations, as his first chief of staff. Succeeding Col Clark as chief of MP&O (G–3) will be Lt Col Fred P. Dyhrmann, assistant G–3 since October 1958.

Curiosity Prickled by 79-year-old Greely Report Leads Researcher to Atmosphere Measuring Device

Because an Army civilian employee's curiosity was piqued by a 79-year-old meteorological report—and because he did something about it—it is now possible to measure the temperature of the atmosphere with an accuracy never before attainable.

Four years ago Glenn E. Daniels, Techniques Branch Chief of the Meteorology Department, U.S. Army Electronic Proving Ground, Fort Huachuca, Ariz., pored through the 1877 annual report on meteorology from the Office of Brig Gen Adolphous W. Greely, then Chief Signal Officer of the Army. The report devoted almost 100 pages to "The Measurement of Atmospheric Temperature."

Up to the time Mr. Daniels closed the book and went to work on the problem, there had never been an instrument capable of approaching 100 percent accuracy in measuring atmospheric temperature. Heat radiation from the ground, the sky, the sun, surrounding objects and even the measuring device itself prevented correct measurement.

Mr. Daniels attacked the problem by first working out an equation which theoretically solved it. On the basis of his equation he contrived a simple-looking but highly scientific modification of a thermocouple, a thermoelectric device used to measure temperature differences. The modified thermocouple all but eliminates the heat radiation factor in temperature readings, reducing previous inaccuracies to a small fraction of a degree.

Months of testing many different models of the compensated thermocouple, which Mr. Daniels fashioned himself, convinced military officers that the technologist's theories were correct and that he had found the answer to the problem of inaccurate temperature readings.

To cap the story: The Army's Chief Signal Officer in Washington, D.C., has accepted the thermocouple adaptation—and the Corps has filed for a patent.

Fort Huachuca Unveils Communications Central

A new wireless, cableless battlefield communications central offering even greater flexibility and reliability than conventional telephones was unveiled recently at the Army Electronics Proving Ground, Fort Huachuca, Ariz.

Known as the AN/MRC–66 Communications Central, the new command control system includes a "radio central" of VHF transmitters, receivers and switchboard facilities mounted on a weapons carrier or ¾-ton truck.

"Subscriber stations," consisting of transmitter and receiver, are mounted in jeeps, ¾-ton trucks, tanks or observation aircraft. Each works through the radio central where incoming radio messages are dispatched by switchboard to other subscriber vehicles, long-distance radio relays or to wire circuits in a static environment.

AN/MRC–66 uses single side band (SSB) radio transmission, allowing more communications channels to operate in a given portion of the crowded radio frequency than previously possible. SSB transmission also provides increased communications range for a given transmitter power output and primary power drain. Modern transistorization is used to the fullest extent.

Exploiting the latest techniques in military communications development, the new system is capable of transmitting and receiving voice, facsimile and radio teletype messages. Top reliability and maintenance ease are achieved through extensive use of built-in test equipment, modular construction and convenient test points.

The first units are slated for delivery in 1961 to the Fort Monmouth Procurement Office of the U.S. Army Signal Supply Agency, Motorola, Inc., has full design and production responsibilities.

Alaskan Battery Zeroes In At 70 Miles With Hercules

In the first of a series of practice firings of Nike Hercules missiles, Battery B, 4th Missile Battalion, 43rd Artillery, Fort Richardson, Alaska, "destroyed" its target at a range of more than 70 miles.

The longest tactical firing intercept ever made with the Nike Hercules, the firing also marked the first time the missile was fired from an operational site near a major metropolitan area. Battery B's launching pad lies in the Chujack Mountains, about 7 miles from Anchorage, Alaska's largest city.

Traveling at more than three times the speed of sound, the missile closed on the target and burst a little more than a minute after the firing button was pressed. A perfect kill was recorded at 40,000 feet altitude.

The "enemy" was an Air Force RB–57 bomber which made its target run from Middleton Island. The battery set a known offset into the equipment, thus using the bomber as a "live" target while placing the burst a safe known distance off target.

Dr. Frolich Retires, Points to Gains in Army Science Program

Before he relinquished the post of Deputy Chief Chemical Officer for Scientific Activities and Chief Scientist, U.S. Army Chemical Corps, effective Dec. 31, Dr. Per K. Frolich was asked if he considers 61 an early age at which to retire. His answer was as definite as one of his formulas.

"Yes, it is," he replied, "and that's just the way I want it. I've worked at a fast pace all my life. Now I want a vacation, I want to be free to do what I want, to travel leisurely with my wife, to read nontechnical books I haven't had time for, to enjoy living without consulting a timetable or an appointments calender. I want to taste freedom—and still have time to go back into harness if I get the urge."

A tall, heavy-shouldered man with a ready sense of humor—who smiles with his eyes as well as his lips—Dr. Frolich said that, after a month or so at their home in Annandale, Va., he and his wife probably will head for the Southwest: Arizona, New Mexico, possibly Mexico. And then? Well, both he and his wife like gardening. Mrs. Frolich also likes to paint, landscapes and portraits. He finds recreation in hiking in the Maine woods, canoeing and fishing.

A native of Norway, Dr. Frolich received his B.S. degree from the Norway Institute of Technology in 1921, taught chemistry and physics for a year, and came to the United States in 1922 as an American-Scandinavian fellow. After receiving an M.S degree from Massachusetts Institute of Technology in 1923, he remained at the Institute until 1929, serving successively as research assistant, research associate, assistant professor of chemical engineering, and associate professor. From 1927 to 1929 he was also assistant director of the Institute's Research Laboratory of Applied Chemistry. In 1925 he was awarded a D. Sc. degree by MIT.

With Army Since 1954

Dr. Frolich became an American citizen in 1929 and in the same year entered industry, joining the Standard Oil Development Co., Elizabeth, N.J. He became a director of the company in 1933 and chief chemist in 1935. From 1936 to 1946 he was director of the chemical division of Esso Laboratories. In 1946 Dr. Frolich left Esso to become coordinator of research for Merck & Co., Inc., manufacturing chemist, Rahway, N.J. Resigning from Merck as vice-president for scientific activities of its chemical division, he became Deputy Chief Chemical Officer for Scientific Activities and Chief Scientist of the Chemical Corps, Department of the Army, on Dec. 1, 1954.

Assigned immediate responsibility

Dr. Per K. Frolich.

for research, development and engineering activities throughout the Chemical Corps, he soon gained an informed appreciation of the broad scope of Army science and the caliber of its scientists.

Challenge to Army

On the eve of his retirement, after 6 years and 1 month in his post, Dr. Frolich remarked: "I have enjoyed my work and associations with the Army tremendously. There are many fine scientists in the Army and in Government. There is a growing awareness of this in industry, as a result of cooperative Army-industry work in the fields of research, development and engineering.

"The challenge the Army faces today in its scientific program lies in its ability to have younger good people coming along to fill gaps all along the rungs of the ladder, from the bottom up. In striving to accomplish this we run into strong competition from industry and universities, yet our job is to set our sights high at the starting level and try our best to get our share."

Dr. Frolich remarked that there is growing recognition among science students at colleges and universities that the Army has something to offer them. Among factors responsible is the interplay among Army scientists and university research teams operating under Army contracts and, particularly, with the aid of basic research grants.

"The respect gained by the university research workers for their Army scientist associates is in many cases passed along to the student scientists. Another avenue along which information about the Army program travels to students is provided by the Chemical Corps Advisory Council, which meets twice each year for several days with the Chief Chemical Officer. The Council and its various committees are composed of 70 members, all top scientific men, about half of whom are connected with universities. The others represent leading industrial concerns."

Dr. Frolich emphasized the importance of Army scientists developing and maintaining contacts with scientists outside their immediate fields, saying: "The more we get out as individual scientists working with universities and industry, the more we help promote appreciation of the significance of the Army's scientific program."

Formerly a president of the American Chemical Society, he holds honorary doctoral degrees from Rutgers and Lehigh Universities. Since 1940 he has been a member of the advisory board of the Research Council of Rutgers. He has also served as a member of the advisory council to the Department of chemical Engineering at Princeton.

Dr. Frolich has contributed about 65 papers to scientific publications, covering work in electro-chemistry, high pressure gas reactions, and other fields, and holds some 70 U.S. and foreign patents, alone or jointly with others. In 1930 he was awarded the Gasselli Medal by the American Section of the (British) Society of Chemical Industry for his studies on organic chemical reactions carried out at high pressure.

World War II Service

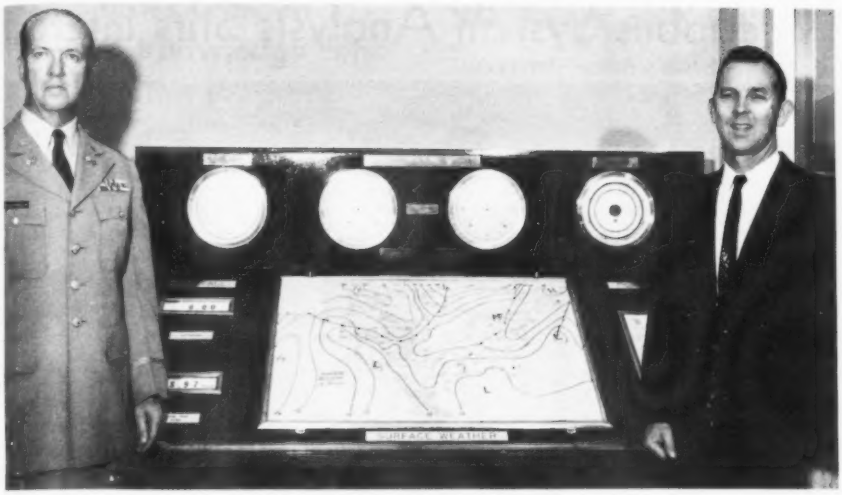
During World War II the former Chemical Corps scientist served on the executive committee of the Chemical Division of the National Research Council and was professional consultant of the Office of Rubber Reserve, the Rubber Reserve Company and the Office of Rubber Director. At the time of his retirement he represented the U.S. Army on the Chemical Division of the National Research Council.

Dr. and Mrs. Frolich have two daughters, Mrs. Elizabeth Ann Bachman, of Boston, and Miss Astrid Frolich, an instructor of physical education at Wellesley College, Wellesley, Mass. Both majored in science in college and worked in commercial laboratories after their graduation.

Astrid teaches skiing, which Dr. Frolich used to enjoy and which he contemplates having a try at again. The last time he had occasion to use his ski boots was after the record snowstorm that buried the Northeastern States Dec. 11, 1960. He wanted them to wear while shoveling snow.

The date of the newspaper in which he found them wrapped told its own story of the work pace he had been keeping, by showing the last time he had an opportunity to go skiing.

The paper was dated 1949.



Col Eric R. Osborne, Mr. Glenn E. Daniel stand beside weather machine.

Huachuca Men Provide Weather-at-a-Glance

The weather-at-a-glance, including current temperature, wind speed, and direction and barometric pressure, as well as a local forecast, is provided for persons who pass through the lobby of Greely Hall, main technical building at the U.S. Army Electronic Proving Ground, Fort Huachuca, Ariz.

The weather information is given by a display console jointly designed and installed by Col Eric R. Osborne, Chief of the Meteorology Department, and Mr. Glenn E. Daniels, meteorologist. Besides the forecast and dials showing prevailing conditions, the console displays a large surface weather map and a national weather resumé, and records the daily and annual rainfall.

Fort Sill Gets Station For Seismic Detection

Ways of detecting and identifying earthquakes and underground chemical and nuclear explosions are the goal of studies at a new seismic research station established at the U.S. Army Artillery and Missile Center, Fort Sill, Okla.

Designated the Wichita Mountains Seismological Laboratory, the station is part of the U.S. seismic improvement program know as Project VELA-UNIFORM. It meets the original conditions of the Conference of Experts, comprising representatives of the United States, United Kingdom, France, Canada, the U.S.S.R., Rumania, Czechoslovakia, and Poland, who met at Geneva, Switzerland, in 1958 to "study the possibility of detecting violation of a possible agreement in the suspension of nuclear tests."

The Wichita Mountains site was selected because minute vibrations of the earth called "microseismic noise," which interfere with detection of signals from distant earthquakes or underground nuclear explosions, are exceptionally small in the area.

The Department of Defense Advanced Research Projects Agency is in charge of overall direction of the Laboratory's program.

Engineers Modify LCM–6 To Increase Capabilities

The U.S. Army Engineer Research and Development Laboratories, Fort Belvoir, Va., have developed an improved equipment set for converting the standard LCM–6 into a fire-fighting and salvage vessel.

A 500-g.p.m. sluicing and fire pump with foam proportioner gives the set greater fire-fighting capabilities than its predecessor. Addition of cutting and welding equipment for above- and under-water use and diving equipment make the set more effective in salvage operations.

A portable diesel-fueled bilge pump that may be transferred to other craft makes possible an auxiliary fireboat when the fire-fighting and salvage set is in use. Other elements of the set include a motor-driven anchor winch, diesel electric generator, lighting equipment for night operations, air compressor, miscellaneous hand tools and an electro-hydraulic crane with a 10,000-pound capacity.

The crane is mounted in the bow of the ship. It is equipped with a standard 17½-foot boom with 10-foot extension to permit pickup over the bow, port, starboard, and aft.

CDEC Testing Unit to Meet Water Supply Threat

Water, water everywhere, but not a drop to drink—the plight of Coleridge's poetic Ancient Mariner—is a situation that may confront troops in atomic warfare. To cope with this threat, the Army is conducting tactical field tests of a mobile purification unit with a rated capacity of 36,000 gallons of drinkable water in 24 hours.

The tests are being made by the U.S. Army Combat Development Experimentation Center at Fort Ord, Calif., in cooperation with the Army Engineer Research and Development Laboratories.

The 1,500-gallon unit, carried within a truck van containing two purification tanks, can be put into operation within a half hour and be ready to dispense potable water an hour later. Water processed by the unit is stored in a collapsible nylon tank.

In the event of nuclear or radiological attack and possible contamination of the water by radio-activity, the mobile unit operated according to established procedures of coagulation, filtration, and disinfection is capable of decontaminating up to 85 percent of gross fission products. With the addition of a clay pretreatment, it can increase the purification up to 93 percent. By the use of a post ion exchange treatment, over 99.9 percent purification may be attained.

Heart of the mobile unit is the Erdlator, an all metal solids contact clarifier which chemically coagulates and removes mud, bacteria and other suspended material in the water and makes effective disinfection possible. Diatomite filters, connected in series to the Erdlator, provide physical barriers to the passage of organisms which cause dysentery and other serious water-borne diseases.

The Erdlator under experimentation is one of a family of newly developed water purification units being considered for standardization by the Army.

Editorial Jobs Open

Persons interested in applying for civil service positions on the editorial staff of the Army Research and Development Newsmagazine may arrange for an interview by telephoning JAckson 5–5800, Ext. 2452 or 2453, Washington, D.C. Or, they may write to the Editor, Army Research and Development Newsmagazine, Army Research Office, OCRD, Department of the Army, Washington, 25, D.C. The *Newsmagazine* is located at Arlington Hall, Arlington, Virginia.

"Big 3" Approach to Weapons System Analysis Stirs Interest

Little did Dr. Alexander Hammer suspect the far-reaching impact on dynamic analysis of a weapon design problem when he made a presentation two years ago entitled "The Big 3—Analytical Design, Photo Analysis, Analog Computer."

The presentation concerned a technique of using three different approaches to solve the same problem. The system was developed by Dr. Hammer, Chief, Analytical Design Laboratory, Research and Development Division, Springfield Armory, and his fellow scientists, Mr. R. F. Ledoux, Chief, Photo Analysis Laboratory, and Mr. E. H. Jakubowski, mathematician.

Originally, they demonstrated "The Big 3" to 160 members and guests of the Western Massachusetts Section of the American Society of Mechanical Engineers at a meeting in the Springfield Armory. Excellent correlation of results, using the Analog Computer, supplemented by a film and slides, impressed the audience recruited from private industry and educational institutions with the high level of work done in Government laboratories.

Recognition and appreciation of the efforts of Springfield Armory to emphasize the theme of Industry-Education-Government relationship swiftly followed. Invitations were extended to the lecturers from the Universities of Massachusetts and Connecticut. In the spring of 1960 "The Big 3" was presented to 300 cadets at the Military Academy at West Point. Fellow engineers in the Arsenal System benefited from it when the subject was presented to members of Watervliet Arsenal Engineering Society at Watervliet, New York. Invitations were accepted from the Hartford and Fairfield County Sections of the American Society of Mechanical Engineers and from the New England Council of Science. Recently Springfield Armory was requested by the Military Academy at West Point to repeat the lecture to at least 300 cadets at the end of each semester.

System Used on Small Arms

Springfield Armory is a small arms research and development center, and the material available at its Analog Computer Center and Photo Analysis Laboratory was used in the solution of a problem selected from the small arms field. The equation of motion of a recoiling mass supported by a ring spring and under the influence of a variable force was analyzed and solved graphically in the basic concept. This concept was extended and applied to a weapon system analysis.

Because the 3-pronged attack on a dynamic problem could be applied to propulsion machinery, pumps, compressors or turbines, as well as to small arms, keen interest was shown wherever "The Big 3" was presented to engineers employed by private industry.

Dr. Alexander Hammer (left to right), Cadet William S. Martin, Col. John Billingsley, Prof. R. F. Ledoux and Head of Department of Ordnance Edwin H. Jakubowski shown at "Big 3" presentation at the U.S. Military Academy.

A side effect developed when Dr. Hammer, at the request of Prof. Joseph M. O'Byrne of the University of Massachusetts, submitted the problem, with all the necessary data and supporting material, to a graduating class in Mechanical Engineering. Professors explained the theory to the class and students were given the opportunity to solve the problem in an exam.

Chain Reaction Results

Later, the graduating class visited the Armory and was given a demonstration of firing a ballistic testing fixture which embodied their dynamic problem in "hardware." High speed motion pictures were taken and in the Analytical Design—Photo Analysis—and Research Laboratories scientists explained the problem and its solution. The future engineers had an opportunity to check the correctness of their own solutions and expressed great interest in the various scientific instruments and methods used in the Laboratories.

The chain reaction induced by "The Big 3" did not stop here. Placement interviewers of the Armory, sent to various New England colleges and universities, found a friendlier and more receptive atmosphere waiting for them when they tried to recruit young engineers for Government service. It was found that appreciation of the methods and instruments used by highly skilled scientific personnel in the various Laboratories greatly influenced the decision of those being interviewed for possible employment.

Thus "The Big 3" clarified the minds of some of the young would-be engineers as to conditions existing in and opportunities offered by Government service. By proving that ingenuity, novel application of basic engineering principles and a high standard of professional ethics dwell within the confines of installations of the Government as well as in those of private industry, it also brought closer together engineers employed by private industry and those working for the Government.

Assigned to Fort Belvoir

The U.S. Army Engineer School at Fort Belvoir, Va., has assigned Col Herrol J. Skidmore as Director of the Department of Engineering, Col Lawrence E. Laurion, Director of the Department of Military Art, and Col L. E. Roth, Director of Logistics Division.

Before his assignment to the Engineer School, Col Skidmore had served as Director of the Engineer Research and Development Laboratories at Fort Belvoir. Col Roth recently returned from Germany where he had been Chief of Installations under the Deputy Chief of Staff, Logistics, USAREUR. Col Laurion was District Engineer, Kansas City

Soil Studies Directed Toward Knowledge for U.S. Missiles Program

Considerable knowledge exists about the behavior of soil under static loads, i.e., foundations, dams, etc., but little is known concerning behavior under dynamic loads. Without this knowledge, the concepts for launchers and recoil structures used for rockets and missiles, and even more conventional weapons, can only be cut-and-try designs.

As a first step in a study of dynamic bearing capacity of all types of soils, the U.S. Army Engineer Waterways Experiment Station at Vicksburg, Miss., recently installed a dynamic loading device to make small-scale footing tests. A comprehensive testing program is contemplated to determine a relationship between dynamic load and deformation of footings. Objective is development of design criteria for weapons structures adapted to the dynamic bearing capacity of soils.

The test apparatus consists of the dynamic load device mounted over a small-scale footing which rests on a soil specimen contained in a large mobile cart. Four or five tests may be performed on each cart of soil by moving the cart along tracks to a desired location beneath the loading device. Test results are obtained by recording the load applied to the footing and the resulting deformation of the footing as a function of time by a direct-writing oscillograph.

The loading device is capable of applying a maximum dynamic load of 50,000 pounds. Gas operated, it has provisions for control of the load rise, dwell, and decay times. The load rise time is controllable from 3 to 150 milliseconds, and the decay time from 20 to 10,000 milliseconds. The footings may vary in size and shape from 3 inches square to about 10 inches square with the apparatus currently available. Additional apparatus is planned to permit tests on footings up to about 2 feet square.

Radiation Detection Drill

Radiation reconnaissance teams and the Radiological Control Center at Fort Belvoir, Va., recently conducted a mock nuclear fallout exercise (RADMON) in conjunction with the Military District of Washington.

Purpose of the exercise was to test the functioning of the reconnaissance teams and the Center in reporting and recording radiation dose rates after a simulated nuclear explosion in the metropolitan area of Washington, D.C.

20 Years of Research Back QM Color Meter

Perfectly reliable matching of colors, important to the "world's largest buyer of textiles" and to some 5,000,000 persons conscious of the "Look Sharp" slogan, is foreseen through use of a device developed after 20 years of research.

Currently undergoing exhaustive tests by the U.S. Army Quartermaster Corps is an automatic color measurement instrument that holds the promise of making human experts in the fine art of color judging seem almost blind by comparison. The machine also records exact data that can be used for future color matching requirements.

Under the single-manager agreement, the Army Quartermaster Corps has the responsibility for procurement of textiles used in the uniforms of members of all the Armed Forces. By totaling the 2,485,000 on active duty with 2,520,000 in the National Guard and the Ready Reserve, who are issued uniforms or who buy them from Army or civilian sales outlets, you come up with a figure that points to the importance of the QM color matching job.

Exactness in matching colors is necessary to assure that material purchased from different mills for military uniforms can be cut and sewed without any apparent difference in shading. Under QM competitive procurement policies, the jacket of a uniform may be furnished by one firm and the pants by another.

Operating principles of the new color meter, the result of progressive improvements of a model first announced in 1940, are explained in a paper presented before the 1960 meeting of the Optical Society of America. Coauthors are the inventor, Richard S. Hunter, president of Hunter Associates Laboratory Inc., McLean, Va., and Frank J. Rizzo, textile dyeing laboratory chief, QM Research and Engineering Center, Natick, Mass. Mr. Hunter was employed by the U.S. Bureau of Standards when he invented the first commercial color meter.

Polar R&D Team Planning Return to "Top of World"

The U.S. Army Polar Research and Development Center's Aviation Section is preparing to return this spring to the "Top of the World," Camp Tuto's Airfield in northwestern Greenland, midway between the Arctic Circle and the North Pole.

The Section returned to Fort Belvoir, Va., late in 1960 following its first season of operations in Greenland, 600 miles from the Pole, where its mission was to support the Center with air transportation for its polar work.

In its initial season on the icecap the Aviation Section's two U–1A "Otters," fixed-wing aircraft, and four H–34C helicopters transported more than 1,300 passengers and over 100 tons of cargo.

Passengers consisted of inspection parties, ranking dignitaries, research scientists and troop replacements. Cargo included rations, construction materials, equipment and tools, and radioactive elements for the Center's portable nuclear power plant at Camp Century, Greenland.

Technicians Simulate Weather Conditions In Ammunition Tests

Mark Twain once observed that "everybody talks about the weather, but nobody does anything about it." That statement is no longer true, because technicians at Picatinny Arsenal, Dover, N.J., now make their own weather.

Members of the Arsenal's Experimental Test and Evaluation Section create all sorts of weather conditions in which they test newly designed ammunition to insure that it will function properly under almost any condition. Related materiel such as rocket launchers, tank parts and electrical components also undergo the rigorous all-weather environmental tests.

Through the use of highly-specialized equipment, the technicians are able to simulate the weather found in jungles, deserts and the Arctic, with a wide variety of humidity, heat, cold, rain, dust, sunshine and even salt spray.

Temperatures from —100° to 250° F. can be achieved in test chambers. At such temperature extremes, some rocket propellants freeze or deteriorate, gun breeches freeze shut and metals become brittle or expand and contract unevenly. Even the concentrated density of the atmosphere in colder areas can affect the performance of a shell. These environmental changes render the items inoperative or cause serious malfunctions.

One test chamber bombards the item under test with sand and dust. Another radiates the entire spectrum of sunlight and drenches the item with "rainfall" up to 24 inches an hour. And still another spews a highly corrosive salt spray.

After passing Picatinny's tests, the items are sent to the Yuma, Ariz., Test Station and Fort Churchill, Canada, for summer-winter tests under a wide variety of actual weather conditions.

TAG Develops Techniques of Special Forces Selection

It is extremely unlikely that an Army recruiting poster ever will address itself to young men in general with the message: "You, too, can be a Special Forces soldier!"

Because a Special Forces soldier must be a special kind of man, physically, mentally and emotionally—and prove that he is before he is put through a grueling period of training.

How does such a man prove to the Army that he will be able to locate and properly cook rattlesnakes, if no other food is available; that he will be capable of living and fighting, often alone, deep behind enemy lines; that he can learn to handle virtually any kind of small arms known to man; that he will be daring enough to blow up bridges, dams and railroads in the enemy's rear?

How can the Army learn in advance whether he will have the stamina to trudge 100 miles or more with full pack, permitting himself only brief rests; that he can develop the necessary skill to patch a bullet wound or a fractured jaw; that he will be competent as a guerilla leader to direct underground fighters whose language he does not even speak; that, in short, he will become a master combat soldier, a teacher, salesman, organizer and diplomat?

Screening Problem Studied

From the time the Army's Special Warfare Center was established at Fort Bragg, N.C., in 1953 Special Forces personnel have always been exceptionally well trained, learning to live off the land—jungle, mountain, desert, or arctic wastes. But not all who volunteered for the training met the rigorous requirements, and the time and money invested in their training was wasted.

Late in 1956, the Director of the Special Warfare Center requested the Chief of Army Research and Development (R&D) to help solve the volunteer screening problem. The project was assigned to The Adjutant General's Personnel Research Bureau (PRB) which is made up of some 70 scientists, principally psychologists. The methodology applied to development of the new test battery was described by Rudolph A. Berkhouse and Milton W. Maier, PRB representatives, before the 1960 American Psychological Association meeting.

The first step was to study the qualifications of successful guerilla leaders. This process included interviews with Special Forces leaders and individuals who had participated in actual wartime guerilla operations. Later the PRB research team took to the field with the troops for first hand study of operations. After determining the attributes of a successful Special Forces soldier, the next step was preparation of a battery of psychological tests designed to identify those individuals who possessed, or did not possess, them. Then came testing of the tests.

New U.S. Army Sniperscope, scheduled for large scale production, permits sharpshooter to spot enemy farther away than its WW II predecessor. Lightweight cartridge belt carries greatly condensed power unit.

To this end, an experimental group of 250 men was selected, consisting in part of men who could not be expected to qualify. Prior to an 11-week training course all were administered the psychological tests. The scores of the known unsuitables were checked out along with the others.

All men in the group were observed and evaluated carefully by their cadremen throughout the course of training. After the training the men were required to demonstrate their proficiency in several tasks a Special Forces man may be called upon to perform.

Test Results Evaluated

For example, trainees had to show they could use radio communications equipment, operate various kinds of weapons, select and utilize various demolitions, perform land navigation problems. Terrain problems were presented in detail by means of sand tables, which held elaborate constructions in miniature: villages, farmhouses, military installations, roads, railroad tracks, telephone lines in various settings, including hills, lakes, swamps, fields and forests.

This post-training demonstration continued two weeks. Experienced cadremen evaluated the trainees on each problem. Checklists evaluating the performance of nearly 300 separate actions essential in Special Forces operations made evaluations as objective as possible.

The evaluation was on an "all or nothing basis"; if the task was performed satisfactorily, the trainee received credit, otherwise he was graded zero. Subsequently, a comparison was made of the pre-training psychological test scores with those made during the two-week demonstration. Four tests were found particularly indicative of qualities needed by a guerilla fighter-leader.

INFANTRY APTITUDE AREA. Here the score is a measure of combat potential obtained during reception processing from scores on tests of the Army Classification Battery. The effectiveness of this measure for Special Forces selection was consistent with the original assumption that the Special Forces soldier must be a highly efficient combat man.

CRITICAL DECISIONS TEST. Problem situations are presented by tape recorder. The trainee is designated "principal actor" and is required to evaluate each of several solutions as to their effectiveness in accomplishing the assigned mission.

LOCATIONS TEST. The problems involved in this test involve a man's ability to orient himself in unfamiliar terrain. The guerilla leader must be able to find his way around without asking directions.

SUITABILITY INVENTORY. This test measures what a man *tends to do* as a result of his personal motivation, rather than what he *can do*.

Faking Made Difficult

The new test battery makes it difficult for an examinee to "fake" responses to any of the tests, PRB officials explained, because very high or very poor scores do not depend on clear-cut answers. A trainee may think he is giving the correct answer when an alternate response may be rated better.

PRB officials believe that use of the four-test battery, added to the selection procedures already in operation, should result in the rejection of two-thirds of those volunteers for the Special Forces who do not possess the appropriate psychological makeup.

"In evaluating volunteers for Special Forces training, it should be remembered that we will be screening a very select group of men," a PRB official noted. "All volunteers must be qualified paratroopers of exceptionally high morale and ability. Nevertheless, we have found that a man might be a fine paratrooper and all-around soldier and still not have that extra motivation and capability required for Special Forces duty."

Currently, three Special Forces groups are on constant training status: one in the United States, another in Europe and a third in the Far East. Present commander of the Army Special Warfare Center at Fort Bragg is Col George M. Jones, who led the 503rd Parachute Combat Team in the taking of Corrigidor, the Philippines, in 1945.

Provocative Ponderables

"You cannot direct research. Research must direct you. If my mother had been directed in her researches she would have found small things. She never would have discovered radium."—Madame Joliot-Curie

* * *

"There are many people, really uncreative, who can get the illusion of creation, if they are a few feet ahead of the masses, no matter how far they are behind the leaders."—Leo Stein

* * *

"Any new theory first is attacked as absurd; then it is admitted to be true but obvious and insignificant; finally it seems to be so important that its adversaries claim that they themselves discovered it."—William James.

* * *

"Which way ought I to go from here?"

"That depends a good deal on where you want to get to," said the Cat.

"I don't much care where . . ." said Alice.

"Then it doesn't much matter which way you go," said the Cat.—Lewis Carroll

* * *

"Here is Edward Bear coming down the stairs now—bump, bump, bump—on the back of his head behind Christopher Robin. It is, as far as he knows, the only way of coming down the stairs. But sometimes he feels that there really is another way, if only he could stop bumping for a moment, and think of it."—A. A. Milne, The World of Pooh

Helicopter Pilot Develops Low Cost Training Device

An Army rotary wing aviator stationed at Mannheim, Germany, has devised a helicopter instrument training aid that costs less than 50 cents to build but may save taxpayers thousands of dollars.

CWO William D. Rundy, of Support Command's 57th Ordnance Group, is the designer of the training aid. The device, a modification of the standard pilot's helmet, forms a hood that prevents the helicopter pilot from seeing anything but his control panel, denying visual reference to outside conditions.

It is constructed from two file guide dividers, paper fasteners and two hose clamps. An important safety feature is its lightness. Made of light fiber material, it has been worn for 2 hours at a time without causing discomfort.

Infantry Board Constructs Unusual Firing Range

An extraordinarily sophisticated firing range, capable of providing more than a half million items of information concerning the performance of one particular type of arms and ammunition, has been constructed at Fort Benning, Ga., by the U.S. Army Infantry Board.

First used to test a new type of small arms ammunition, the range was designed to duplicate realistically the offensive and defensive phases of combat as experienced and recorded during World War II and in Korea.

Construction of the range involved the excavation of approximately 1 mile of trenches, 136 individual foxholes, and 13 large bunkers to accommodate 260 targets, 3 generators, and 92 miles of wiring.

Stationary and moving targets are tactically located to represent enemy troops, 160 for defensive phases of testing and the remaining 100 for attack phases. All utilize M31 Target Holding Mechanisms, electrically operated devices which enable each target to be raised or lowered at specific times or to be "killed" by a bullet.

All targets are wired to a master electric tape programmer that raises and lowers them automatically in a planned sequence. Exposure times vary from 3 to 50 seconds, depending upon the cover and concealment afforded and the representative movements of each enemy rifleman.

Firing Conditions Varied

Targets vary in size, sequence of appearance, degree of visibility and range from the firer. During defensive firing phases, 12 minutes in length, the first targets appear at a range of 450 meters from the defensive position. Subsequently, targets appear at closer ranges, as those at farther ranges disappear.

The entire sequence is programed to simulate the speed at which an advancing enemy would attack, and the range has separate positions for testing during daytime and at night.

In the initial tests held on the range a "typical" 11-man infantry squad was devised on the basis of the marksmanship qualifications of an average rifle company. The tips of all bullets were colored with dye, which transferred itself to tarkets that were hit. By this method, the marksmanship qualifications of men, the type of weapons and the type of ammunition used can be determined.

Information Processed

These data, along with 67 other items of information, were recorded on IBM cards for each target and each firing order (one squad). In all, some 8,000 cards with 70 items of information per card—a total of approximately 560,000 items—were processed to provide information to the Infantry Board.

Design of the range is credited to Maj Melvin E. Gustafson, a test officer of the Small Arms Department, U.S. Army Infantry Board. Maj Gustafson spent weeks researching and evaluating various factors before submitting the final design for approval.

Ordnance Guide Issued On Machining Processes

A Machining Data Book, the first complete guide for machining operations in ordnance work, has been completed.

The book was prepared by Metcut, Inc. under the technical supervision of Rock Island Arsenal, headquarters of the U.S. Army Ordnance Weapons Command. Francis J. Daasch, Chief Machinability Section of Rock Island's Laboratory, conceived and coordinated the project.

Numerous technical problems had to be resolved in the preparation of the guide which is one of the most ambitious machinability information projects ever undertaken. Basic data was gathered by visits to Army arsenals and industrial firms as well as by thorough research of pertinent literature.

As new machining processes are introduced it will be necessary to update the data book to retain maximum usefulness. Because of its comprehensive coverage, the book should be of value not only to Army Ordnance but to any organization engaged in the machining of metals.

ARPA Announces Appointment

Charles F. Yost, formerly Director of Solid State Sciences, Air Force Office of Scientific Research, has been appointed Assistant Director for Materials Sciences in the Advanced Research Projects Agency. Prior to his service with the Air Force, Mr. Yost had been with the National Bureau of Standards, the Atomic Energy Commission, the Office of Naval Research and the Applied Physics Laboratory of Johns Hopkins University, Baltimore, Md.

Betts, Starbird Reassigned

Brig Gen Austin W. Betts, former Director of the Advanced Research Projects Agency, Office of the Director of Defense Research and Engineering, Washington, D.C., has succeeded Maj Gen Alfred D. Starbird as Director of Military Applications, U.S. Atomic Energy Commission, Germantown, Md. General Starbird's new assignment is Division Engineer, North Pacific Engineer Div., U.S. Army, Portland, Oreg.

Fluid Amplification Principles Arousing Wide Response

Seldom does an invention or exciting discovery involving a new system represent a simplification of that which preceded it. Something new or novel is expected to be more "sophisticated" and, for the most part, more complex.

A refreshing departure from this trend was revealed just a year ago, in March 1960, at a press conference conducted at the Army's Diamond Ordnance Fuze Laboratories (DOFL) in Washington, D.C., when the Laboratories' system of "Fluid Amplification" was announced. Wire services and 25 technical and trade journals exploited the story, resulting in a virtual deluge of interest. Industrial firms from all parts of the United States and five foreign countries made inquiries.

Five in-house presentations of the system have been made for representatives of industrial concerns and a sixth is scheduled. More than 300 companies have sent representatives to DOFL and many visiting college professors have received briefings.

Working models demonstrating principles involved have been exhibited in five states (twice in the Coliseum in New York City by request) and have served to increase the interest of commercial and laboratory concerns.

Because of the widespread response to the potential application of fluid amplification systems, the editors of the Army Research and Development Newsmagazine requested the Diamond Ordnance Fuze Laboratories to prepare a special article on the basic principles involved, as follows.

By J. A. Wheeler, Jr., PIO, DOFL

In countless industrial and military applications, fluids in motion are used to perform a wide variety of tasks. Machine tools, steam engines, internal combustion engines, rocket motors, and many other devices depend upon precise and timely control of moving fluids for proper operation. Applications of the theory of hydraulics and pneumatics together with thermodynamics have given us rugged and reliable systems which range all the way from windshield wipers and hydraulic brakes to rocket motors and giant hydroelectric generating stations.

With rare exceptions, these systems employ moving (solid) parts such as pistons, valves, diaphragms, or vanes to control the fluid flow. In many applications the use of such moving parts does not prevent the system from operating as intended. However, in other cases a system with moving parts suffers limitations because of friction, thermal expansion or deterioration, or because of the inertia or weight of these parts. From the viewpoints of reliability, ruggedness, and storage life, simplification of a system by elimination of parts is surely desirable.

Our purpose here is to describe a class of devices and related systems which use moving fluids as their working substance, but which have no moving parts. In some ways they are similar to electronic systems, which also have no moving parts, but the analogy is only approximate, since the basic laws governing electron flow and fluid flow are different.

The basic building block of the fluid-actuated systems we will discuss is the amplifying element i.e., the *pure fluid amplifier*, just as the vacuum tube and transistor constitute the basic building blocks of electronic systems.

Fluid amplification with the aid of moving parts is already very widely used and system using this type of amplification are very well developed. For example, the sliding valve on a steam locomotive is a fluid amplifier. *Pure fluid amplifiers* accomplish amplification without moving parts.

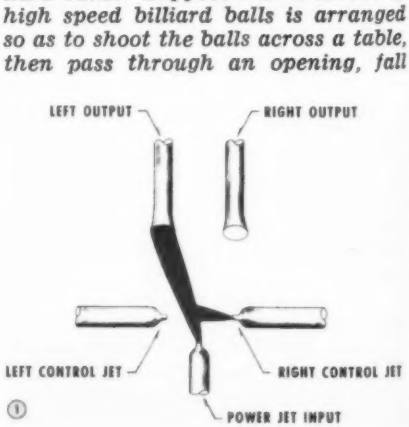
The basic idea of a pure fluid amplifier is to direct a low power stream of fluid against the side of a high power stream. The low power stream, which we call the control stream, is used to displace or redirect the power stream, i.e., the control stream tells the power stream where to deliver its energy.

Everyone is familiar with the fact that high velocity fluid streams can do tremendous amounts of work. The jet of water from a fire hose can do great damage to a house, and high speed jets of water are used in some mining operations. We also see that high speed jets of gas can do great quantities of work as they drive the modern aircraft at supersonic speeds. It it the energy of the moving fluid in the power stream which provides the output energy of a pure fluid amplifier. This is the energy that is controlled by the control stream.

If the power stream can be controlled by a lower power level than that of the power stream, the device may properly be called an amplifier. Since it is done without the use of moving parts, it can be called a *pure fluid amplifier.*

Sometimes there is a question concerning the meaning of the term "amplification." *First, amplifiers do not make energy; they only control it; they tell the energy when to go or where to go.* Ordinary vacuum tubes control the energy supplied by the battery or power supply by controlling the rate of flow of electrons through the tube. Other types of vacuum tubes, for example, the beam deflection type, control the direction of flow of the electrons. Pure fluid amplifiers are related to this latter type of vacuum tube amplifier, or to push-pull arrangements of the first type.

This amplification by stream interaction is similar to an amplifying action which can be achieved with billiard balls. Suppose that a source of high speed billiard balls is arranged so as to shoot the balls across a table, then pass through an opening, fall



①

GLOSSARY

Fluid-actuated System—A system in which a liquid or gas is the working substance.

Pure Fluid System—A fluid-actuated system having no moving parts.

Amplifier—A device which permits a given amount of power (or energy) to control the delivery of a greater amount of power (or energy) to a load.

Pure Fluid Amplifier—An element which permits a control stream to direct a more energetic power stream without the use of moving parts.

Power Stream—The high energy stream in a pure fluid amplifier which carries the energy which is delivered to the output of the amplifier.

Control Stream—The low energy stream in a pure fluid amplifier which directs the power stream and thus determines the way in which the power stream energy is delivered to the output of the fluid amplifier.

Feedback—The process of having some of the output power of a device introduced back into its input to achieve special effects such as oscillation, bistable operation, stable gain or other effects.

Bistability—The property of being able to exist in only one of two possible states.

Flip Flop—A bistable device having a power gain.

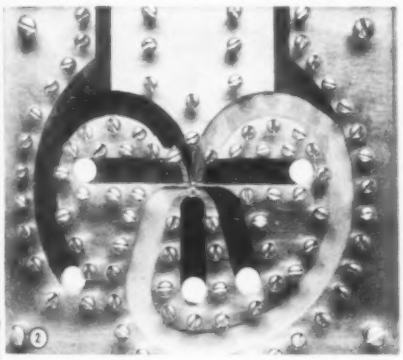
Aperture—An opening through which some or all of the power stream flows.

Power Supply—(In a fluid-actuated system) A source of fluid under pressure.

down, and do some useful work. Now if a slow speed billiard ball were directed from the side against each of the high speed balls, they could be deflected, causing them to pass through a different opening and do their work somewhere else. This control of a high energy stream with a lower energy stream, whether it be billiard balls, liquid or gas, is amplification.

The deflection of a power stream by a control stream is shown in the diagram of the first photograph. It is important that the power stream not be destroyed by the deflecting action. In other words, it must retain its integrity. If the power stream were completely disrupted by the deflecting action, the amplifier would not work.

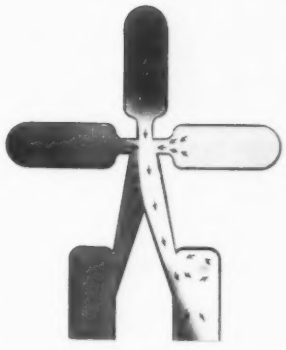
The second photograph shows a flip-flop suitable for use in a digital computer or digital control system. Feedback paths from the output apertures to two additional control nozzles (feedback nozzles) have been added, so as to "lock" the power stream in one path or the other. The unit can be changed from one of its two states to the other



by introducing a small flow of fluid into one of the regular control nozzles.

The third photograph is a diagram of a control element in which pressure in the region between the side wall and the power stream is used to help deflect the power stream. The use of a larger area in deflecting the power stream makes such a unit sensitive to very low control pressures.

Figure No. 4 is a Schlieren photograph showing the flow of air through a pneumatic flip-flop which has a feedback action within the stream interaction chamber. The power stream is shown "locked" to the left wall by a low pressure region which the power stream itself regenerates. It will stay locked to this side as long as fluid for the power stream is supplied, or until it is directed to the other side by the control stream. This principle of locking to a sidewall makes possible a memory unit so "stubborn" that the power stream will stay locked in the path toward which it was last directed by the control stream, even though the



flow out the aperture on that side may be completely blocked.

Using the principles illustrated in the photograph, and other closely related effects, a whole new class of amplifiers, computer logic circuits, and control systems is made possible. A number of these have been demonstrated and there are many others.

One of the most attractive features of a fluid-actuated system without moving parts is its ruggedness. It consists only of a solid having appropriate passages and a fluid. The inherent simplicity should make it extremely reliable.

The capability of a pure fluid amplifier for a high temperature operation undoubtedly goes far beyond that of any other known amplifying action, since the operation depends only upon the shape of a solid and the flow properties of a fluid. In this area, pure fluid amplifiers and computers have no competitor. A properly designed unit could operate at white heat if a refractory material were used for the body, and a stable, noncorrosive gas as the fluid.

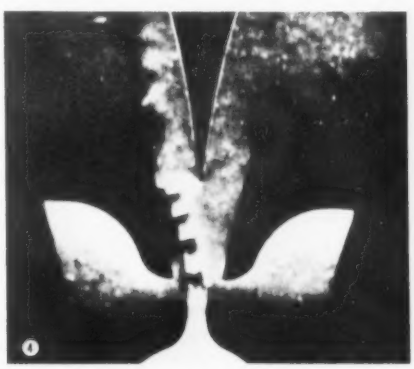
An important limitation of fluid-actuated systems is speed. They will never compete with electronic systems for the very high speed applications, but are much faster than fluid systems with moving parts, and their speed is entirely adequate for many applications, both military and industrial.

Fluid amplifying and controlling elements without moving parts appear to be usable in many of the present-day fluid-actuated systems. Their inherent simplicity, ruggedness, and low cost should make for rapid exploitation. In the field of new and improved fluid-actuated control systems these new amplifiers and computers make possible great increases in speed of response.

Similarity exists between the way fluids are controlled in present-day fluid systems and the way electricity was controlled before the vacuum tube. In those days generators produced current controlled by switches, transformers and rheostats. If you had asked an electrical engineer what kind of actuation and control he could accomplish, he undoubtedly would have said "just about anything you want." Electricity could be controlled effectively, but only by moving parts.

Then in 1907 DeForest brought out his three-element "audion," which was the first triode. This made it possible for electrons to control the flow of electrons without the use of any other control medium. Furthermore, the triode could amplify. These two characteristics, the use of only one medium and the ability to amplify, have been responsible for the contribution of the vacuum tube, and now the transistor, to the field of electricity.

Pure fluid amplifying and computing elements are expected to take a place in hydraulic and pneumatic systems similar to the position that the vacuum tube and transistor occupy in the field of electricity. In this age of high technological development and good communication, principles are likely to be propagated much more rapidly than



was the case with the vacuum tube, which came forth when there was no widespread need for it and electronic control systems were unknown. The vacuum tube had to make its place in the world.

Pure fluid amplification comes at a time when there are tens of millions of fluid-actuated systems in daily use, involving for example: food handling, petroleum and chemical processing, piping natural gas and liquids, hydroelectric generating station control, machine tool control, air conditioning and heat regulation, positioning devices, windshield wipers, power steering, air hammers, and washing machines.

Since pure fluid elements can amplify, count, perform logical operations and regulate time intervals, they can perform many of the control operations required in such applications—reliably and at lower cost than present systems.

T-Thoughts on Research and Engineering Management

Dr. Ralph G. H. Siu, Technical Director, Office of the Quartermaster General, Department of the Army, is known for his wit as well as his wisdom and abilities as a scientist. His "T-Thoughts on Research and Engineering Management" have proved stimulating to members of the Senior Scientists Advisory Council, of which he is a member. The Newsmagazine is privileged to broaden his audience through this regular column.

By Dr. Ralph G. H. Siu

The Cadillac Motor Co. formulated the following statement on "The Penalty of Leadership."

"In every field of human endeavor, he that is first must perpetually live in the white light of publicity. Whether the leadership be vested in a man or in a manufactured product, emulation and envy are ever at work.

"In art, in literature, in music, in industry, the reward and the punishment are always the same. The reward is widespread recognition; the punishment, fierce denial and detraction. When a man's work becomes a standard for the whole world, it also becomes a target for the shafts of the envious few. If his work be merely mediocre, he will be left severely alone—if he achieves a masterpiece, it will set a million tongues a-wagging. Jealousy does not protrude its forked tongue at the artist who produces a commonplace painting. Whatsoever you write, or paint, or play, or sing, or build, no one will strive to surpass or to slander you, unless your work be stamped with the seal of genius. Long, long, after a great or a good work has been done, those who are disappointed or envious continue to cry out that it cannot be done. Spiteful little voices in the domain of art were raised against our own Whistler as a mountebank, long after the world had acclaimed him its greatest artistic genius. Multitudes flocked to Bayreuth to worship at the musical shrine of Wagner, while the little group of those whom he had dethroned and displaced argued angrily that he was no musician at all. The little world continued to protest that Fulton could never build a steamboat, while the big world flocked to the river banks to see his boat steam by.

"The leader is assailed because he is a leader, and the effort to equal him is merely added proof of that leadership. Failing to equal or to excel, the follower seeks to depreciate and to destroy—but only confirms once more the superiority of that which he strives to supplant. There is nothing new in this. It is as old as the world and as old as human passions—envy, fear, greed, ambition, and the desire to surpass. And it all avails nothing.

"If the leader truly leads, he remains—the leader. Master-poet, master-painter, master-workman, each in his turn is assailed, and each holds his laurels through the ages. That which is good or great makes itself known, no matter how loud the clamor of denial. That which deserves to live—lives."

The U.S. Army Transportation Corps' new all-terrain dynamometer vehicle, now christened the Terrapin, is capable of a speed of 35 miles an hour on hard ground and can carry 5 tons of cargo on land and 2½ tons on water. It travels on rubber pads over the tracks which cushion the vehicle against hard surfaces, greatly reducing noise and protecting highways from damage usually associated with crawler tractors. Engineers Herman P. Simon (left) and Carlo J. Roma are shown with Maj. Loren J. Pretty, Transportation Corps, discussing the Terrapin's radically new treads.

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